FINAL SUBMITTAL

ENERGY SURVEYS OF ARMY INDUSTRIAL FACILITIES ENERGY ENGINEERING ANALYSIS PROGRAM RADFORD ARMY AMMUNITION PLANT RADFORD, VIRGINIA

VOLUME II

APPENDICES

89

CONTRACT NO. DACA65-[redacted]-C-0154

PREPARED FOR:

U.S. ARMY CORPS OF ENGINEERS
NORFOLK, VIRGINIA

PREPARED BY:

ENERGY AND ENVIRONMENTAL SERVICES DEPARTMENT
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MARCH 1991

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
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REPLY TO
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Marie Wakefield,
Librarian Engineering

VOLUME II

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APPENDIX A

PRENEGOTIATION MINUTES NOTES
RADFORD AAP INDUSTRIAL FACILITIES STUDY

Attendees: Graham Ellixson
Paul Hutchins

Date: 08/25/89

- Entire project will require about 13 months.
- Give formal presentation at each conference (2).
- Graham will provide a list of submission copies requirements.
- Intent is to find energy savings in industrial processes, not buildings. Therefore, much of the data requested in the SOW for building envelop data [SOW 3.1.4] is superfluous and should have been gathered in the previous EEAP. Graham suggested that I use my judgement in these matters. Our philosophy concerning this is as follows: if the building is conditioned because of process-related requirements, then building envelop data are required. If the building is conditioned for personnel comfort only, then the envelop data are not required.
- Remove EMCS from SOW.
- Concentrate on smaller projects--stay away from ECIP.
- Update three projects from previous EEAP.
- No solar.
- Will send Graham examples of linear regression analysis.
- Rescheduling of production lines at Radford will be difficult.
- Send map of Radford areas and building lists to Graham.
- RAAP has requested that A/E <u>not</u> package projects for funding source and documentation. RAAP prefers to do this.

Appendix "A"

CENAO-EN-MP

July 1989

DETAIL/GENERAL SCOPE OF WORK

ENERGY SURVEYS OF ARMY INDUSTRIAL FACILITIES

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)

RADFORT ARMY AMMUNITION PLANT (RAAP)

RADFORD, VIRGINIA

SCOPE OF WORK
ENERGY SURVEYS OF ARMY INDUSTRIAL FACILITIES
ENERGY ENGINEERING ANALYSIS PROGRAM

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1. BRIEF DESCRIPTION OF WORK: The Architect-Engineer (AE) shall:

1.1 Perform a complete energy audit and analysis of the industrial facility.

1.2 Identify all Energy Conservation Opportunities (ECOs) including low cost/no cost ECOs and perform complete evaluations of each.

1.3 Prepare programming and implementation documentation for all justifiable energy conservation opportunities.

1.4 List and prioritize all recommended energy conservation opportunities.

1.5 Prepare a comprehensive report which will document the work accomplished, the results and the recommendations.

2. GENERAL:

2.1 A coordinated energy study, including a detailed energy survey, shall be accomplished for the industrial facility. The study shall integrate the results of and any available data from prior or ongoing energy conservation studies, projects, designs, or plans. This Scope of Work is not intended to prescribe the methods in which the study is to be conducted or limit the AE in the exercise of his professional engineering expertise, good judgment or investigative ingenuity. However, the information and analyses outlined herein are considered to be minimum essentials for adequate performance of this study. The study shall include a comprehensive energy report documenting study methods and results.

2.2 All ECOs recommended shall comply with all current criteria (e.g., environmental, safety) for the industrial facility. These criteria may have changed since the facility was constructed. Replacement of people with automation systems may allow reductions in outside air quantities, ventilation rates, and similar items resulting in significant energy savings. Stated requirements for special environments (temperature/humidity control) for industrial equipment and processes shall be researched as needed by the AE to verify (a) the requirement and (b) the degree of control essential for the industrial mission.

2.3 All recommended ECOs, including maintenance, operational and low cost/no cost opportunities as well as Energy Conservation Investment Program (ECIP) and Energy Conservation and Management Program (ECAM) projects shall be ranked in order of highest to lowest Savings Investment Ratio (SIR).

2.4 An Energy Engineering Analysis Program (EEAP) study has been accomplished for the installation. Applicable portions of the study, ~~if any,~~ shall be updated as needed and incorporated into the report. The report shall list

the recommended ECOs from the previous study that pertain or should pertain to industrial facilities processes. This list shall summarize the ECOs (cost, short description, and anticipated energy savings) and identify the fiscal year for which the project was or is programmed. Any industrial facility related ECO identified in the previous studies but not recommended shall be reevaluated under this contract. Any industrial facility related ECO recommended from the previous studies but not implemented nor programmed for implementation shall be updated in accordance with the latest ECIP criteria. Three (3) projects as per D-5.

2.5 The terms "industrial," "production," and "process" are used interchangeably in this Scope of Work and should be interpreted broadly to include research, test and development, end item maintenance and repair, supply and distribution, as well as the typical "production centers" in Army industrial facilities. The term "facility" means one or more buildings or enclosures together with the equipment installed therein. It implies an integrated production system which requires a coordinated approach to achieve the best overall results.

2.6 The "Energy Conservation Investment Program (ECIP) Guidance," described in letter from DAEN-MPO-U, 10 August 1982 and revised by letters from DAEN-ZCF-U, 4 March 1985 and 11 June 1986, establishes criteria for ECIP/ECAM Projects and shall be used for performing the economic analyses of all ECOs and projects. ~~Construction cost escalation for DD Form 1391 submission shall be calculated using the guidelines contained in AR 415-17 and the latest Tri-Service MCP index. The Tri-Service MCP Index, when updated, is contained~~ in the latest applicable edition of the Engineer Improvement Recommendation System (EIRS) bulletin.

2.7 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable to installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP/ECAM or MCA funding, and determining, in coordination with installation personnel, the appropriate packaging and implementation approach for all feasible ECOs.

2.8 Projects which qualify for ECIP/ECAM funding shall be identified, separately listed, and prioritized by Savings Investment Ratio (SIR).

2.9 All energy saving opportunities shall be listed and prioritized by SIR.

3. <u>WORK TO BE ACCOMPLISHED:</u>

3.1 Audit. The audit consists of gathering data and inspecting industrial facilities in the field, including those which are government-owned, contractor operated (GOCO). These activities shall be closely coordinated with the contractor operator at GOCOs, facilities or plant engineer representatives, production engineers, the installation commander or his representative, and the Government's representative. The AE shall become thoroughly familiar with the facility and its industrial mission and undertake all necessary field trips to

obtain required data. The AE shall consolidate or summarize the survey data to make it concise, and shall submit the summarized data as part of the report. Data sources shall be identified and assumptions clearly stated and justified. All test and/or measurement equipment shall be properly calibrated prior to its use.

3.1.1 Boiler plants, chilled water plants, incinerators, and similar facilities listed in Annex D that are associated with the industrial facility shall be included in the study. The intent is to determine the condition of existing equipment, efficiency of boiler plant equipment, operational procedures, adequacy of plant capacity, and heat recovery possibilities in addition to the general items listed.

~~3.1.2 During the audit process promising applications of solar energy for industrial processes shall be identified. Tremendous amounts of steam and hot water are used in industrial facilities dictating active consideration and analysis of potential solar applications.~~

3.1.3 The audit shall be conducted with the view that the term "industrial facility" means an integrated production infrastructure including the building envelope, industrial equipment, process standards, materials, utilities and other components of the industrial operation which have an energy value.

Envelope energy and process energy are interrelated. Inputs and outputs, particularly of thermal energy, should be balanced in order to optimize overall energy efficiency of industrial facilities. ECOs should therefore reflect the "systems" approach for a totally integrated facility, and assure that any energy trade-offs between buildings and processes are analyzed.

3.1.4 Data collected during the audit shall, as a minimum, include:

3.1.4.1 Building data.

a. Building number, building age, number of floors, and gross square feet.

b. Floor area, HVAC zones, nonair-conditioned spaces, and usage of space ("industrial" or "other").

c. Glass areas.

d. Wall and roof surface areas and condition, type of construction, and "U" factors.

e. Drawings, equipment schedules, shop layouts, utilities distribution diagrams, etc.

f. Nameplate data of energy related building equipment.

g. Any major expansions, alterations, or modernization projects.

3.1.4.2 Weather information.

3.1.4.3 Operating methods.

a. Facilities operating hours (peacetime).

b. Personnel strength (direct labor).

c. Facilities system and equipment operating and maintenance schedules.

d. 3.1.4.3.4 Control set points, chilled water temperatures, and freeze protection temperatures.

e. Rooms, areas, or zones with special or critical requirements.

3.1.4.4 Past performance records.

a. Energy peak demands.

b. Latest annual energy consumption (Gross BTU/yr, BTU/SF/yr, BTU/end product/yr) for total installation and facility(ies) being studied.

c. Utility rate schedules.

d. Energy conservation projects (ECIP/ECAM/other) in facilities being studied.

3.1.4.5 Energy sources.

3.1.4.6 Production data.

a. Production areas by type utilization (e.g., fabrication, finishing, assembly, test, storage, etc.).

b. Production equipment schedules, age, utilization, and energy requirements.

c. Production equipment replacement or modernization plans.

d. Process flow layouts.

e. Production rates/quantities.

f. Material handling systems.

g. Expected changes (equipment, process, facilities, workload, etc.).

3.2 Analysis. The energy analysis is a comprehensive study of the industrial facilities energy usage. It includes a detailed investigation of the operation, environment and equipment. Computer modeling shall be used to in-

corporate field survey data, weather data, production data, operation schedules, building construction data, energy distribution systems and equipment data into a model of the total facility. The computer program shall, for varying production rates (peacetime levels and full mobilization), develop load profiles, calculate energy savings, and evaluate the energy requirements of the industrial facility, using a "Linear Regression" model program. The computer results should be verified by comparing them to any available past utility bills or records. The A-E shall submit a sample computer run with an explanation of all input and output data, and a summary of program methodology and energy evaluation capabilities for approval by the Contracting Officer prior to use of the program for analysis.

3.2.1 The energy analysis shall provide the following types of information:

a. A baseline of energy usage of the existing facility (at current production capacity prior to implementing ECOs generated by this study).

b. Comparison of equipment capacities with current workloads.

c. Process related energy usage by systems (lighting, heating, cooling, process, etc.).

d. Basis for evaluating ECOs.

e. A baseline of energy usage of the facility after incorporation of all recommended ECOs (assuming no change in production level).

3.2.2 The AE shall develop graphic presentations, i.e. graphs and charts which depict a complete energy consumption picture for the industrial facility both presently and after implementation of energy saving recommendations.

3.2.3 The AE shall develop a listing of each shop, zone, or area of the facility as appropriate. The list shall include the air handling system and humidity setpoints, lighting levels and similar data. The valid criteria requirements for supply, return and exhaust air quantities, temperature and humidity setpoints, lighting levels, etc., shall also be shown. The listing shall be in sufficient detail so that areas with potential energy savings can be identified. The AE shall be familiar with the latest Army environmental and safety criteria and shall evaluate installed systems for possible energy saving revisions which may be permitted by current criteria.

3.2.4 If data is available, the AE shall develop an historical load profile by year for the past three fiscal years for each energy source utilized.

3.2.5 The AE shall project energy costs for three fiscal years from the date of contract award. Department of Energy (DOE) projections are acceptable.

3.3 Identify ECOs. All methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures and maintenance practices as well as the physical facilities. A list of energy conservation opportunities is included as Annex A to this scope. This list is not intended to limit or guide the AE but only to assure that at least these opportunities are considered. Each of the items shall be discussed in the report. Those items on the list which are not practical, have been previously accomplished, are inappropriate or can be eliminated from detailed analysis based on preliminary analysis shall be listed in the report along with the reason for elimination from further analysis. All potential ECOs which are not eliminated by preliminary considerations shall be thoroughly documented and evaluated as to technical and economic feasibility. The AE shall provide all data needed to support the recommended ECO. All assumptions shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an orderly step-by-step progression from the first assumption to the final number. A Life Cycle Cost Analysis Summary Sheet shall be prepared for each ECO and included as part of the supporting data.

3.4 Energy Monitoring and Control Systems (EMCS)/Process Control System (PCS).

3.4.1 The AE shall determine the feasibility of an EMCS/PCS for the industrial facility. The intent of this study is to determine the basic conceptual architecture of the EMCS/PCS to the extent that primary economic calculations can be made to determine feasibility per ECIP criteria. The documentation shall be of sufficient accuracy to insure that future project design calculations that will be done after completion of this study will not deviate more than 20 percent from the results of this study.

3.4.2 The AE shall survey all buildings and perform feasibility evaluations in accordance with guidance in HNDSP-84-076-ED-ME. Any existing basewide EMCS project or any currently under design or study shall be considered and evaluated for intergration. The use of existing survey data is acceptable only if it is in sufficient detail and can be easily revalidated by building walk through inspections. The standard evaluation forms contained in HNDSP-84-076-ED-ME shall be a part of the submittal. EMCS/PCS analyses and evaluations shall be developed using TM 5-815-2. Energy savings calculations shall be in accordance with NCEL CR 82.030. The AE shall consider connection of the industrial facility to this basewide system. An independent system for the industrial facility and some type of communication with the basewide system for monitoring and data gathering shall also be considered. EMCS/PCS evaluations shall consider but not be limited to the following features:

a. Start/Stop Programs

Scheduling
Duty cycling
Load shedding for electrical demand limiting
Lighting control
Start/Stop Optimization

b. Ventilation and Recirculation Programs

Dry bulb economizer
Outside air reduction
Industrial process economizer
Exhaust air reduction/optimization (based on production activity)

c. Temperature Reset Programs

Space temperature night setback
Process temperature night setback
Hot and cold deck
Reheat coil
Chilled water
Chiller selection
Boiler selection

d. Labor Savings/Monitoring (Example: Boiler plant monitoring (EMCS/PCS logging of points which are present are manually logged.)

e. Machine run time, production profiles and maintenance management

3.4.3 The AE's recommendations for an EMGS/PCS shall be in sufficient detail to define the system configuration, the approximate quantity and types of control instruments and sensors, and the data transmission system. The selection of points to be monitored and controlled shall be given priority based upon ECIP criteria. The control system functions, expected energy reduction, and monetary savings (including the manner in which these savings are to be achieved) shall be explained.

3.4.4 The AE shall prepare and provide recommendations in narrative form. Input/output (I/O) summary tables shall be prepared and provided for each system selected in accordance with HNDSP-84-076-ED-ME. Cost estimates shall be prepared and provided in accordance with HNDSP-84-076-ED-ME for the mechanical and electrical modifications required to implement the EMCS/PCS.

3.4.5 Inoperative controls shall be surveyed in accordance with TM 5-815-2. Cost estimates to repair and replace inoperative controls shall be as described in HNDSP-84-076-ED-ME.

3.4.6 Labor savings/monitoring shall be included, provided the SIR is not affected to the extent of jeopardizing the ECIP requirements.

3.5 Project Documentation. All energy conservation opportunities (ECOs) the AE has considered shall be included in one of the following categories and presented as such in the report:

3.5.1 ECIP/ECAM Projects. To qualify as an ECIP/ECAM project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $200,000 and Savings Investment Ratio greater than one and a

simple payback period of less than ten years. For ECAM projects, the $200,000 limitation may not apply. The AE shall check with the installation for guidance. The overall project, and each discrete part of the project, shall have a SIR greater than one. For all projects meeting the above criteria, complete programming documentation will be required. Programming documentation shall consist of a ~~DD Form 1391,~~ Life Cycle Cost Analysis Summary Sheet(s) (with necessary backup data to verify the numbers presented), and a project development brochure (PDB). These forms shall be separate from the report. They shall be bound similarly to the final report in a manner which will facilitate repeated disassembly and reassembly. A Life Cycle Cost Analysis Summary Sheet shall be developed for each ECO and for the overall project when more than one ECO is combined. For projects and ECOs updated or developed from the previous studies, the backup data shall consist of copies of the original calculations and analysis, with new pages updating and revising the original calculations and analysis. In addition, the backup data shall include as much of the following as is available: the increment of work the project or ECO was developed under in the previous study, title(s) of the project(s), the energy to cost (E/C) ratio, the benefit to cost (B/C) ratio, the current working estimate (CWE), and the payback period. This information shall be included as part of the backup data. The purpose of this information is to provide a means to prevent duplication of projects in any future reports. For projects or ECOs the installation wants submitted as ECIP/ECAM projects, complete programming documentation shall be prepared.

~~3.5.1.1 Military Construction Project Data (DD Form 1391). These documents shall be prepared in accordance with AR 415-15 and the supplemental requirements in Annex B. A complete DD Form 1391 shall be prepared for each project. The form shall include a statement that the project results from an EEAP study. Documents shall be complete as required for submission to higher DA headquarters. These programming documents will require review and signatures by the proper installation officials. All documents shall be complete except for the required signatures.~~

3.5.1.2 Project Development Brochures (PDBs). Preparation of PDBs requires the AE to delineate the functional requirements of the project as related to the specific site. The AE shall prepare PDBs in accordance with AR 415-20 and TM 5-800-3. Most projects will not require all the forms and checklists included in the Technical Manual (TM). Only that information needed for the project shall be included. The PDB-I format described in the TM shall be used for whatever information is needed.

3.5.1.3 Supporting Data. The AE shall provide all data and calculations needed to support the recommended project. Descriptions of the products, manufacturers catalog cuts, pertinent drawings, and sketches shall also be included. A Life Cycle Cost Analysis Summary Sheet shall be prepared for each ECIP project and each discrete part of the project and included as part of the supporting data.

3.5.2 Non-ECIP/ECAM Projects. Projects which normally do not meet ECIP/ECAM criteria, but which have an overall SIR greater than one shall be

individually packaged and fully documented. The Life Cycle Cost Analysis Summary Sheet shall be completed through and including line 6 for all projects or ECOs. Each shall be analyzed to determine if they are feasible even if they do not meet ECIP/ECAM criteria. These ECOs or projects may not meet the nonenergy qualification test. For projects or ECOs which meet this criteria, the Life Cycle Cost Analysis Summary Sheet, completely filled out, with all the necessary backup data to verify the numbers presented, a complete description of the project and the simple payback period shall be included in the report. ~~Additionally, these projects shall have the necessary documentation prepared, in accordance with the requirements of the Government's representative, for one of the following categories:~~

a. Quick Return on Investment Program (QRIP). This program is for projects which have a total cost not over $100,000 and a simple payback period of two years or less.

b. OSD Productivity Investment Funding (OSD PIF). This program is for projects which have a total cost greater than $100,000 and a simple payback period of four years or less.

c. Productivity Enhancing Capital Investment Program (PECIP). This program is for projects which have a total cost of more than $3,000 and a simple payback period of four years or less.

The above programs are described and documentation shall be prepared in accordance with AR 5-4, Change No. 1.

d. Regular Military Construction Army (MCA) Program. This program is for projects which have a total cost greater than $200,000 and a simple payback period of ten to twenty-five years. Projects or ECOs which qualify for this program shall be economically analyzed in accordance with the requirements for Special Directed Studies in Engineering Technical Letter (ETL) 1110-3-332. Documentation shall be in accordance with paragraph 3.5.1 except that the economic analysis required by ETL 1110-3-332 shall be included in lieu of the ECIP Life Cycle Cost Analysis.

e. Low Cost/No Cost Projects. These are projects that the installation can perform using their funds. For these projects the following information shall be provided:

(1) Brief description of the project.

(2) Brief description of the reasons for the modification.

(3) Specific instructions for performing the modification.

(4) Estimated dollar and energy savings per year.

(5) Estimated manhours and labor and materials costs. Costs shall be calculated for the current calendar year and so marked. Manhours shall be

listed by trade. For projects that would repair an existing system so that it will function properly, also include the estimated manhours by trade and labor and material costs necessary to maintain the system in that condition. Some of the simple practical modifications may be developed on a per unit basis. An example of this type of modification would be the repair or replacement of steam traps on an as needed basis. As a rule, however, the AE should develop complete projects, if at all possible, rather than per unit modifications. Separate sheets for each project showing the above information shall be prepared and included in the report.

3.5.3 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they were rejected.

4. DETAILED SCOPE OF WORK: The general Scope of Work is intended to apply to contract efforts for all Army industrial facilities except as modified by the detailed Scope of Work for each specific installation. The detailed Scope of Work is contained in Annex D.

5. PROJECT MANAGEMENT

5.1 Project managers. The AE shall designate a project manager to serve as a point of contact and liaison for all work required under this contract. Upon award of this contract, the individual shall be immediately designated in writing. The AE's designated project manager must be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for coordination of work under this contract. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work required under this contract. This individual will be the Government's representative. The Project Manager designated for the Norfolk District Corps of Engineers is Mr. Graham J. Ellixson, Ph, (804) 441-7214

5.2 Installation assistance. The Commanding Officer or contractor operator at each installation will designate an individual who will serve as the point of contact for obtaining information and assisting in establishing contacts with the proper individuals and organizations as necessary to accomplish the work required under this contract. That individual designated for RAAP is Ms. Joanne Wills.

5.3 Public disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed under this contract, except as authorized by the Contracting Officer.

5.4 Meetings. Meetings will be scheduled whenever requested by the AE or the Contracting Officer for the resolution of questions or problems encountered in the performance of the work. The AE and/or the designated representative(s) shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer.

5.5 Site visits, inspections, and investigations. The AE, consultants, if applicable, and/or designated representative(s) thereof shall visit and inspect/investigate the site of the project as necessary and required during the preparation and accomplishment of the work.

5.6 Records

5.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representatives(s) thereof participated. These records shall be dated and shall identify the contract number, and modification number if applicable, participating personnel, subject discussed and conclusions reached. The AE shall forward to the Contracting Officer within ten (10) calendar days, a reproducible copy of the records.

5.6.2 The AE shall provide a record of requests for and/or receipt of Government-furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of work under this contract. The records shall be dated and shall identify the contract number and modification number, if applicable. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the record or receipt.

6. SUBMITTALS, PRESENTATIONS AND REVIEWS

6.1 General. The work accomplished shall be fully documented by a comprehensive report. The report shall have a table of contents and be indexed. Tabs and dividers shall clearly and distinctly divide sections, subsections, and appendices. All pages shall be numbered. The AE shall give a formal presentation of all but the final submittal to installation, command, and other government personnel. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted on the same day following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. The AE shall provide all comments and written notification of the action taken on each comment to all reviewing agencies within three weeks after the review meeting. It is anticipated that each presentation and review conference will require approximately one working day. The presentation and review conferences will be at the installation on the date(s) agreeable to the AE and the Government's representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose. Conference schedules are as provided in the Detail Scope.

6.2 Interim submittal. An interim report shall be submitted for review after completion of the field survey and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and

contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings and SIRs of all the ECOs shall be included. The simple payback period of all ECOs shall be calculated and shown on the report. The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing the work and results to date shall be a part of this submittal. During the review period, the Government's representative and Facilities Energy Coordinator shall provide the A-E with direction for packaging or combining ECOs for programming purposes. ~~A sample programming document (DD Form 1391), PDB and supporting data) for one ECIP/ECAM project shall be submitted with this submittal for review and approval prior to the preparation of the other programming documents. To the degree possible, the project selected for the sample submission shall be typical of the majority of subsequent projects to be submitted. This sample shall consist of complete project documentation with primary emphasis on format and manner of presentation rather than precise accuracy of cost estimates and~~ energy saving ~~data.~~ The survey forms completed during the audit shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within.

6.3 Prefinal submittal. The AE shall prepare and submit the prefinal report when all of the work under this contract is complete. The AE shall submit the Scope of Work for the installation studied and any modifictions to the Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The report shall include an order of priority by SIR in which the recommended ECOs should be accomplished. Completed programming and implementation documents for all recommended new and reevaluated projects shall be included. The programming and implementation documents shall be ready for review and signature by the installation commander. The prefinal report, Executive Summary, and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The prefinal submittal shall be arranged to include (a) a separately bound Executive Summary, to give a brief overview of what was accomplished and the results of this study using graphs, tables and charts as much as possible (see Annex C for minimum requirements), (b) the narrative report containing a copy of the Executive Summary at the beginning of the volume and describing in detail what was accomplished and the results of this study, (c) appendices to include the detailed calculations and all backup material and (d) the programming and implementation documentation. A list of all projects and ECOs developed during this study shall be included in the Executive Summary and shall include the following data from the Life Cycle Cost Analysis Summary Sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR and the analysis date. For all programmed projects also include the year in which it is programmed and the programmed year cost. The simple payback period shall also be shown for these projects and ECOs.

6.4 Final submittal Any revisions or corrections resulting from comments made during the review of the prefinal report or during the presentation shall be incorporated into the final report. These revisions or corrections may be in the form of replacement pages, which may be inserted in the prefinal report. or complete new volumes. Pen and ink changes or errata sheets will not be acceptable. If replacement pages are to be issued, it shall be clearly stated with the prefinal submittal that the submitted documents will be changed only to comply with the comments made during the prefinal conference and that the volumes issued at the time of the prefinal submittal should be retained. Failure to do so will require resubmission of the complete volumes. If new volumes are submitted, they shall be in standard three-ring binders and shall contain all the information presented in the prefinal report with any necessary changes made. Detailed instructions of what to do with the replacement pages should be securely attached to the replacement pages.

7. OPERATION AND MAINTENANCE INSTRUCTION. The AE shall prepare a one-day instructional course for the mechanical and electrical operation and maintenance personnel and affected production supervisors to explain possible energy saving potentials due to modified equipment and systems operation. The course will identify operational items noted during the audit, in both facilities and process areas, which will effect energy conservation, and will explain the savings possible. This course will be held near the end of the study period at a time agreeable to the AE and the Government's representative. This course is in addition to the formal review and presentations required. An outline of the topics that will be covered shall be submitted with the prefinal report.

8. ENTRY AND EXIT INTERVIEWS. The AE and the Government's representative shall conduct entry and exit interviews with the Facilities or Plant Engineer and other interested managers before starting work at the facility and after completion of the field work. The Government's representative shall schedule the interviews at least one week in advance.

8.1 The entry interview shall thoroughly describe the intended procedures for the survey. As a minimum, the interview shall cover the following points:

a. Schedules.

b. Names of energy analysts who will be conducting the site survey.

c. Proposed working hours.

d. Support requirements from the facilities or plant engineer.

e. Limitations imposed by production operations.

f. Plant security and safety procedures.

8.2 The exit interview shall include a thorough briefing describing the work accomplished, problems encountered, probable areas of energy conservation, and any follow-on efforts which may be required.

9. SERVICES AND MATERIALS. All services, supplies, materials (except those specifically enumerated to be furnished by the Government), plant, labor, superintendence and travel necessary to perform the work and render the data required under this contract shall be included in the lump sum price of the contract.

ANNEX A

ENERGY CONSERVATION OPPORTUNITIES (ECOs)

ECOs shall not be recommended if their implementation would be detrimental to the facility's mission during peacetime. ECOs which may pose a constraint on mobilization production requirements shall include an analysis thereof, along with recommended contingency actions. Industrial process ECOs shall include, but not be limited to, the following:

a. Production equipment replacements, modifications, disposals.

b. Energy efficient motors and variable frequency drives.

c. Scheduling/loading of production equipment.

d. Waste heat recovery from industrial processes.

e. Automated control of production equipment - integrated with existing or proposed EMCS equipment, if appropriate.

f. Improve facility layout and space utilization.

g. Solar applications.

h. Consolidate processes and equipment requiring special environments.

i. Building ventilation, exhaust systems.

j. Production equipment maintenance.

k. Improved methods/controls to reduce scrap, rework, and "goldplating," which consume energy without contributing to production mission.

l. Steam distribution and condensate return systems.

m. Compressed air distribution systems, equipment and controls.

n. Lighting control (zones, levels, etc.). (Efficient types)

o. Electrical Distribution.

p. Radiant heating.

q. Loading dock seals.

r. Thermal storage.

CONTINUATION OF
ANNEX A

ENERGY CONSERVATION OPPORTUNITIES (ECOs)

- Boiler flue gas recirculation

- Ventilation versus air conditioning

- Insulation

- Reduction of glass area

- Improve efficiency of compressed air systems

- Cargo door strip curtains for controlled humidity warehouses

- Energy efficient ballasts

ANNEX B

REQUIRED DD FORM 1391 DATA

To facilitate ECIP/ECAM project approval, the following supplemental data shall be provided:

a. In title block, clearly identify project as "ECIP" or "ECAM."

b. Complete description of each item of work to be accomplished including quantity, square footage, etc.

c. A comprehensive list of building zones, or areas including building numbers, square foot floor area and usage (administration, production, etc.).

d. Complete list of production equipment, process controls and ancillary equipment to be installed or retrofitted.

e. List references, assumptions and provide calculations to support life cycle dollar and energy savings and indicate any added costs.

(1) If a specific building, zone or area is used for sample calculations - identify the building, zone or area, category, age, square footage floor area, window and wall area for such. For a specific piece of production equipment or system - provide complete description, environmental requirement, manner of operation, age, etc.

(2) Identify weather data source, if applicable.

(3) Compare process-building systems interface before and after improvements.

(4) Provide and justify process criteria and temperature profiles before and after retrofit of buildings or modification of process. Include source of expertise and demonstrate savings claimed by process energy contributions, exhaust or outside air quantities, temperatures, humidity, production flow, etc.

f. Recommended process/equipment efficiency improvements must identify data to support present properly adjusted operation and future expected efficiency. If full replacement of equipment is indicated, explain rejection of alternatives such as repair, nonfunctioning controls, etc. Assessment of the complete existing installation is required to make accurate determinations of required retrofit/replacement.

g. An ECIP/ECAM Life Cycle Cost Analysis Summary Sheet as shown in the ECIP guidance will be provided for the complete project and for each discrete part included in the project. The SIR is applicable to all segments of the project. Supporting documentation consisting of basic engineering and economic calculations showing how savings were determined shall be included.

h. The DD Form 1391 face sheet shall include, for the complete project, the annual dollar and MBTU savings, SIR, simple amortization period and a statement attesting that all buildings and production equipment will be in active use throughout the amortization period.

i. The calendar year in which the cost was calculated shall be clearly shown on the DD Form 1391.

j. For each temporary building included in a project, separate documentation is required showing (1) a minimum 10-year continuing need, based on the installation's annual real property utilization survey, for active building retention after retrofit, (2) the specific retrofit action applicable, and (3) an economic analysis supporting the specific retrofit.

k. Nonappropriated funded facilities will not be included in the ECIP project without an accompanying statement certifying that utility costs are not reimbursable.

l. Any requirements required by ECIP guidance dated 10 August 1982, and any revisions thereto. Note that unescalated costs/savings are to be used in the economic analyses.

m. The five digit category code number for all ECIP/ECAM projects developed under this scope of work is 80000.

ANNEX C

EXECUTIVE SUMMARY GUIDELINE

1. Introduction.

2. Building Data.

3. Present Energy Consumption.

   o Total Annual Energy Used.

   o Source Energy Consumption.

Electricity	- KWH, Dollars, BTU
Fuel Oil	- GALS, Dollars, BTU
Natural Gas	- THERMS, Dollars, BTU
Propane	- GALS, Dollars, BTU
Other	- QTY, Dollars, BTU

   o Energy Consumption by Systems.

4. Historical Energy Consumption.

5. Production Profile and Trends.

6. Energy Conservation Analysis.

   o ECOs Investigated.

   o ECOs Recommended.

   o ECOs Rejected. (Provide economics or reasons)

   o ECIP/ECAM Projects Developed. (Provide list)*

   o Non-ECIP/ECAM Projects Developed. (Provide list)*

   o Operational or Policy Change Recommendations.

* Include the following data from the Life Cycle Cost Analysis Summary Sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR and the analysis date. For all programmed projects also include the year in which it is programmed and the programmed year cost. Show the simple payback period for all ECOs.

7. Energy and Cost Savings.

   o Total Potential Energy and Cost Savings.

   o Percentage of Energy Conserved.

   o Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented Based on Projected Workloads.

8. Energy Plan.

   o Project Breakouts with Total Cost and SIR.

   o Schedule of Energy Conservation Project Implementation

ANNEX D

DETAIL SCOPE OF WORK

ENERGY SURVEYS OF ARMY INDUSTRIAL FACILITIES

ENERGY ENGINEERING ANALYSIS PROGRAM

TABLE OF CONTENTS

6776s/1b

AREAS/BUILDINGS TO BE AUDITED

Due to the large number of buildings and diversity of building types it is impractical to list each individual building number. The intent is to survey buildings that contain the more energy intensive processes. It has been determined through discussions with RAAP personnel and review of existing energy data that the following production areas are the large energy users. Where there are multiple buildings of the same type, a single representative building will be surveyed.

AREAS	BLDG. NOS.	# OF BLDGS.
Nitrogylcerin		
#2	9400's	57
Nitrocellulose		
B	2000's (28)	
C	3000's (39), 4026	68
Waste Acid A & B	420's	9
Cast Propellent	4912-1 thru 4912-27 (62) 4912-36, 4913 (4), 4915 (5) 4919 (2), 4921 (4), 4924-1-7 (9), 4928, 4952	86
Pilot "B"	4912-28 thru 4912-54 (52), 4925, 8902, 8903, 9126	56
Pilot "A"	5008's (4)	4
Ignitor Line	5010, 5011, 5012, 5016, 5027	5
Solvent Propellent		
Green Lines		
B	2500's (40),	
C	3500's (48), 3670-3693 (34)	122
Inert Gas Plant	421, 4903	2
Solvent Recovery		
B	1609-1617 (36), 1659-1667 (27), 1728-1730 (12)	75
C	1618-1626 (36), 1668-1676 (27), 4910's (9), 1731-1733 (15), 4911's (9)	94
Finish Areas		
B	1757-1762 (6)	6
C	1763-1765 (3), 3655-3658 (4), 3675-3678 (8)	15
Common Finish Area	1825-1888 (36), 4934's (2)	38

AREAS	BLDG. NOS.	# OF BLDGS.
Wastewater Treatment	4325, 7226, 424, 470's (3), 9126 5502	8
Incinerators	425, 429, 440, 441, 450	5
Acid	700's	32
Solventless Propellent		73
Premix 1	7102's (7), 7103's (8) 3647-3650 (4), 4904, 4905, 4932	22
RP1	7104-7112 (31), 7121 (2), 7124-7160 (11), 7221 (3), 3712-3751 (18)	65
Grain Finish	7800-7803 (5)	5
F-Line	7113	1
RP4	9300's (42)	42

Supplying these production lines with energy are the following:

Boiler/Power Houses	400, 4329	2
Compressed Air	700, 4705-01, 4333	3
Pump Houses	407, 408, 409, 404, 455, 4330	6

SPECIFIC ECO'S

1. Incinerators - Building 440 and 441, oil fired, study alternative fuels.

2. Boilers and Chillers - Other boilers in addition to Buildings 400 and 4329 and small chillers as located in Buildings in the study.

SUMMARY OF ENERGY CONSERVATION OPPORTUNITIES
(IN DESCENDING E/C PRIORITY)

Project No.	Project Description	CWE In 1984 Dollars	E/C Ratio	B/C Ratio	Energy Saved, MBTU/Yr.	Dollars Saved, $/Year	Payback Period, Years	Action
--	Install Gate Valve in 8" Main at TNT Area	14,021	230.0	-	3,224	11,761	1.2	Valve already installed
--	Replace Defective Steam Traps	23,955	70.8	-	1,695	7,437	3.2	Dropped because of existing steam trap maintenance program
T-102-G	Replacement and Installation of Gate Valves	191,537	69.4	4.7	13,295	52,578	3.6	Submitted Increment G, EC/CC = 4.95
T-105	Ambient Sensing Steam Control Valves	536,089	48.1	1.7	25,808	79,876	6.7	Submitted Increment A
T-101	Individual Bay Heaters for FAD Houses	102,895	32.6	3.0	3,352	15,284	6.7	Submitted Increment A
--	Final Wringer Timers	31,454	31.6	-	995	5,134	6.1	Timers already installed
T-108	Change House Modifications	135,200	28.4	4.2	3,838	36,000	3.8	Submitted Increment A
--	Return Condensate System for TNT Area	323,384	25.5	-	8,240	33,142	9.8	Condensate system already installed
T-104	Heat Pipe for FAD Houses	2,385,729	25.3	1.6	60,349	306,448	7.8	Submitted - Increment A
--	Heat Recovery For Air Dry House	690,755	23.5	.76	16,225	18,146	38.1	Not submitted because B/C < 1
T-106	Return Condensate System Plant-Wide	3,786,679	21.1	1.1	79,716	328,520	11.5	Submitted - Increment B
WO-111G	Replace Plastic Blow-out Panels with Insulated Panels, Mix House	18,254	21.0	1.1	383	1,185	15.4	Submitted Increment G, EC/CC - 1.17
T-107	Steam Tie-Line Linking Power House 400 with Horseshoe Area	6,881,510	20.3	7.2	139,777	1,098,614	2.2	Submitted Increment B (Design Completed under WE project)

Project No.	Project Description	CWE in 1984 Dollars	E/C Ratio	B/C Ratio	Energy Saved, MBTU/Yr.	Dollars Saved, $/Year	Payback Period, Years	Action
T 109	Insulating and Weather-proofing Combined Shops, Solventless Press House, and 4th Rolled Powder Line	387,756	18.9	1.1	7,346	23,737	16.3	Submitted Increment A
T 103	Heat Recovery for Curing Houses	615,143	17.6	1.7	10,849	58,723	10.5	Submitted · Increment A
-	Weatherize Change Houses	279,728	15.8	-	4,410	16,308	17.2	Already in progress under WE program.
WO-113G	Insulate Wall & Roof, Ether Still House	23,300	13.3	.7	309	956	24.4	Submitted Increment G, EC/CC = 0.74
--	Insulate Wall & Roof Cotton Pulp & Dry House	42,095	12.3	-	518	1,916	21.2	E/C not valid; violates safety regulations
WO-112G	Installation of Photocell at 4th Rolled Powder for Walkway Lighting	8,032	11.5	1.6	92	1,341	6.0	Submitted Increment G, EC/CC = 0.83
-	Insulate Wall & Roof Press & Cutting House	40,337	10.9	-	441	1,631	24.7	E/C not valid; violates safety regulations.
-	Insulate Wall & Roof, Mix House	35,219	10.7	-	378	1,398	25.2	E/C not valid; violates safety regulations.
✓ WO 114G	Water Dry Tank Covers	230,302	8.6	12.9	1,973	322,810	0.7	Submitted Increment G, E/C = 0.48
	Replace Drive Shafts with Individual Mixers at Poacher Blender Houses	2,481,000	8.6		21,487	110,870	22.4	E/C not valid.
T 110G	Installation of HPS Lighting in Combined Shops, Boiling Tub Basement and Wringer Houses	354,493	7.9	1.2	2,793	27,954	12.7	Submitted Increment G, EC/CC = .91

SCHEDULE OF ACTIVITIES

Activity	Calendar Days (NTP Plus)
NTP	0
Interim Submittal	205
Interim Review Conference	250
Prefinal Submittal	295
Prefinal Review Conference	335
Prefinal (Corrected)/Final Submittal	365

SCHEDULE OF ACTIVITIES

Activity	Calendar Days (NTP Plus)
NTP 10/23/89	0
Interim Submittal	205
Interim Review Conference	250
Prefinal Submittal	295
Prefinal Review Conference	335
Prefinal (Corrected)/Final Submittal	365

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SUBMITTAL DISTRIBUTION LIST

ADDRESS	INTERIM (60%)	PREFINAL (90%)	FINAL (100%)
Commander U. S. Army Engineer Division, North Atlantic ATTN: CENAD-EN-MM 90 Church Street New York, NY 10007	2 cys	2 cys	1 cy
Commander Office of Chief of Engineers ATTN: CEEC-EE (McCarty) Pulaski Building Washington, DC 20314	Executive Summary only	1 cy	1 cy
Commander U. S. Army Engineer District, Norfolk ATTN: CENAO-EN-MP (Ellixson) 803 Front Street Norfolk, Virginia 23510	3 cys	3 cys	2 cys
Army Energy Office ATTN: DALO-LEP (Keath) New Cumberland Army Depot New Cumberland, PA 17070	Executive Summary only		
Commander USAMC Installations & Services Activity ATTN: AMXEN_B (G. Badtram) Building 60, 2nd Floor Rock Island, IL 61299-7190	1 cy	1 cy	1 cy
Commander U. S. Army Ammunitions PDN Base Modernization Agency, Picatinny Arsenal ATTN: AMSMC-PBE(D) (Yose Yamoza) Building 171 Annex Dover, NJ 07801	2 cys	2 cys	1 cy
Commander Radford Army Ammunition Plant ATTN: SMCRA-OR (J. Wills) Radford, VA 24141-0298	2 cys	2 cys	1 cy
Totals	10 cys	12 cys	8 cys

GOVERNMENT FURNISHED CRITERIA

(1) Building information schedule (manual).

(2) Production equipment schedule.

(3) Utility procurement records (including reimbursable).

(4) Facilities engineering technical data support.

(5) Equipment modernization/acquisition plan.

(6) Basic utility systems information maps.

(7) Equipment layout and utilization records.

(8) Final reports of previously completed studies performed under the Energy Engineering Analysis Program (EEAP). Only portions pertaining to the industrial facilities, if any, need to be made available (attached, See D-5, D-6).

(9) Latest copies of any other energy studies performed since the previous EEAP study. Only portions pertaining to the industrial facilities, if any, need to be made available.

(10) Installation Energy Plan.

~~(11) Army Facilities Energy Plan.~~

(12) ETLs 1110-3-282, Energy Conservation; ~~1110-3-318, Procedures for Programming Energy Monitoring and Control Systems (EMCS) Funded through the MCA Program;~~ and 1110-3-332, Economic Studies.

(13) Energy Conservation Investment Program (ECIP) Guidance, dated 10 August 1982, and revisions dated 4 March 1985 and 11 June 1986.

~~(14) Information on Existing EMCS Studies, Designs, Construction Contracts, or Operating Systems.~~

(15) TM 5-785, Engineering Weather Data; TM 5-800-2, General Criteria Preparation of Cost Estimates; TM 5-800-3, Project Development Brochure; an~~d TM 5-815-2, Energy Monitoring and Control Systems (EMCS). (TM 5-815-2 need only be furnished if items 14, 17, and 18 are furnished.)~~

(16) AR 415-15, Military Construction Army (MCA) Program Development; AR 415-17, Cost Estimating for Military Programming; AR 415-20, Construction, Project Development and Design Approval; AR 415-28, Department of the Army Facility Classes and Construction Categories; AR 415-35, Construction, Minor Construction; AR 420-10, General Provisions, Organization, functions, and Personnel; AR 11-27, Army Energy Program; and AR 5-4, change No. 1, Department of the Army Productivity Improvement Program.

~~(17) HNDSP 84-076-ED-ME, Preliminary Survey and Feasibility Study for Energy Monitoring and Control Systems.~~

~~(18) NCEL CR 82.030, Standardized EMCS Energy Savings Calculations.~~

(19) The latest applicable Engineer Improvement Recommendation System (EIRS) Bulletin.

(20) An example of a correctly completed programming document for an ECIP/ECAM Project.

(21) Production data.

(22) Architectural and Engineering Instructions, DAEN-ECE-A, dated 13 March 1987.

SPECIAL REQUIREMENTS AND INFORMATION

1. Point of contact at Radford AAP and Liaison for all work required under this contract is:

Joanne Wills
Radford Army Ammunition Plant
ATTN: SMCRA-OR
Radford, Virginia 24141-0298
Phone: AV 931-7480, (804) 639-7480

2. The Fiscal Year to which all ECIP projects should be estimated to and programming or implementation documents prepared for is FY 92. Depending on project packaging, the Installation Commander may determine different program years for the final report. Remaining projects shall be escalated to a FY TBD.

3. A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee. The computer program can be used for performing the economic calculations for ECIP and non-ECIP ECO's. The A-E is encouraged to obtain this computer program. The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61801. The telephone number is (217) 333-3977. A-E shall indicate in writing what program will be used.

4. Consolidated review comments will be provided to A-E by Project Manager about 14 days prior to review conferences. A-E will review each comment and provide consolidated proposed reponses to Project Manager 48 hours prior to conference.

5. A-E will provide cover letter with all submittals noting a review is required and that a Review Conference is scheduled approxiamtely 45 days hence. Letter will also inform recipients of letter to follow from Norfolk District C.O.E. setting exact conference date.

APPENDIX B

BACKUP DATA AND CALCULATIONS

TABLE OF CONTENTS

Energy Prices and Economic Parameters

Energy Prices:

Purchased Electricity, 3,413 Btu/Kwh, \$8.87/MBtu, \$0.03026/kwh (average cost)
Energy charge: \$4.93/MBtu, \$0.0168/kwh
Demand Charge: \$7.12/KW/Month
Source: Rate schedule and Radford AAP estimate

Fuel Oil #2, 138,690 Btu/Gallon, \$4.27/MBtu
Source: November 2, 1989 invoice

Natural Gas, 1.031 MBtu/Kcf, \$3.36/MBtu
Source: October 1989 Natural Gas Billing

Coal (Bituminous), 24.58 MBtu/Ton, PH#1 - \$1.61/MBtu, PH#2 - \$1.78/MBtu
Source: Radford AAP CY 1990 average delivered coal costs

Energy Savings/Costs:

Coal Savings: 1.32 MBtu coal/MBtu 40 psig steam
1.21 MBtu coal/MBtu 275 psig steam

Electricity Purchase vs. Generation Price Differential Cost: \$1.11/MBtu 40 psig steam
\$0.35/MBtu 275 psig steam

Basis For Cost Estimates:

Adjustment	Labor	Material	Comments
Location	0.683	1.002	Only for estimates by Means, based on Roanoke, VA values
Sales Tax	N.A.	4.5 %	Includes state and local
FICA/Insurance	20.0%	N.A.	-
Overhead	15.0 %		-
Profit	10.0 %		-
Performance Bond	1.0 %		-
Contingency	5.0 %		New construction
	7.5 %		Modernization
	10.0 %		Renovation work
Hercules Support	6.0 %		-
SIOH	5.5 %		-
Design Fees	6.0 %		-

All costs are adjusted to January 1990.

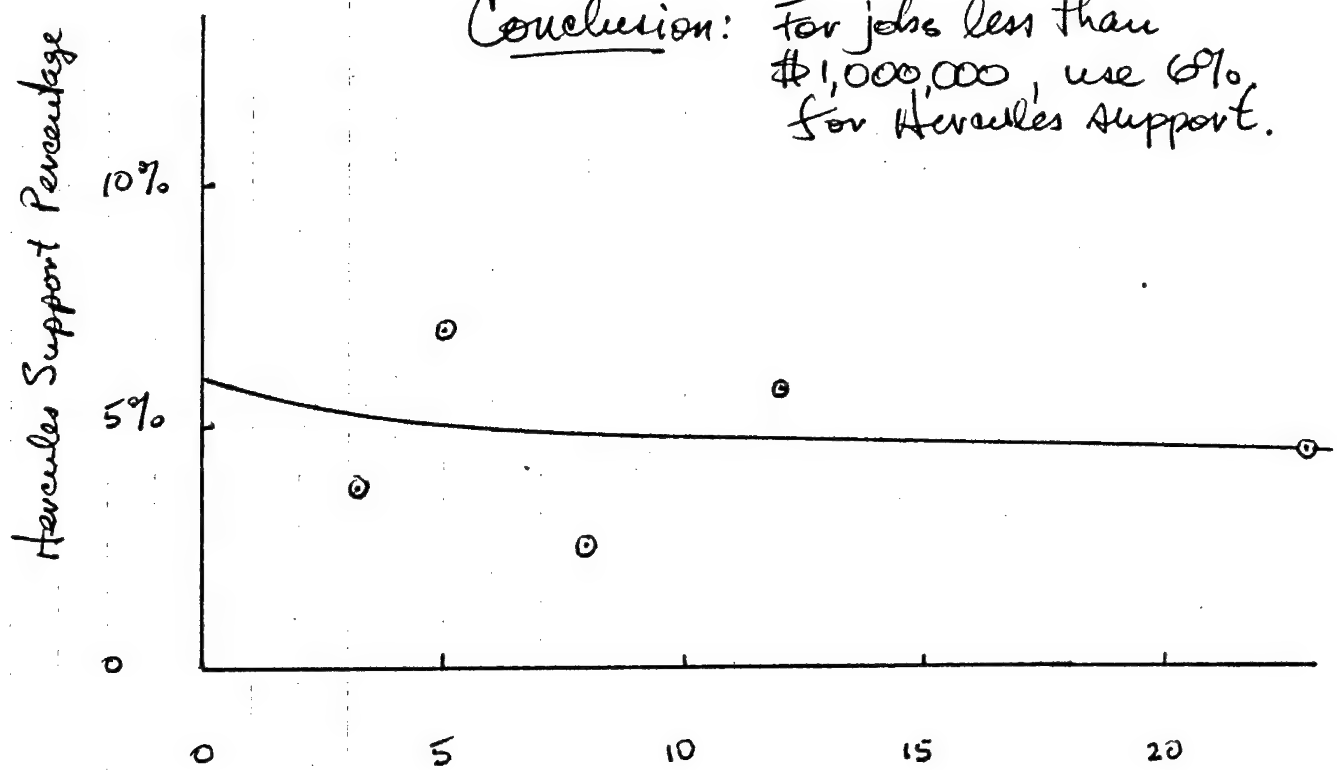
REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT Hercules Support Services
DESIGNER PFH
CHECKER
AEP NO
SHEET / OF
DATE 5/18
DATE

Hercules Support Services

Total job	Hercules Support
$23,000,000	3.5 %
$ 8,000,000	2.6 %
$ 5,000,000	7.0 %
$ 12,000,000	5.8 %
$ 3,200,000	3.8 %

Conclusion: For jobs less than $1,000,000, use 6% for Hercules support.



EFFECTS OF STEAM SAVINGS ON POWERHOUSE #1 COAL USE AND POWER PRODUCTION

It is known that when process steam flow is reduced at the point of use in the production areas, there are two effects on energy purchases at Powerhouse #1. First, coal use is decreased and second, less electricity is generated due to the decrease in steam flow. Therefore, less coal is purchased and more utility-generated electricity is purchased. The following are the detailed calculations used to determine the change in coal use and electricity production at Powerhouse #1 when steam use is reduced due to implementation of an energy saving project.

The approach taken was to perform heat balances for three cases:

Base Case:	Typical operating conditions
Case 1:	10,000 #/hr reduction in 40 psig process steam
Case 2:	10,000 #/hr reduction in 275 psig process steam

All pressures, temperatures and enthalpies were provided by RAAP except the final exhaust enthalpy. The final exhaust enthalpy was calculated using the turbine/generator performance chart and determining power production with no extractions. Coal use and electricity production were calculated for each case using fundamental engineering principles. The differences between the Base Case and Case 1 and the Base Case and Case 2 provided the steam-to-coal conversion factors and electricity price differential costs which are summarized at the beginning of this section.

STEAM-TO-COAL CONVERSION FACTOR

AND ELECTRICITY PRICE DIFFERENTIAL COST EXAMPLES

<u>Example #1</u>

Calculate savings due to 1 MBtu reduction in 40 psig steam use.

Coal savings = 1.32 MBtu (coal)/MBtu (steam) * 1 MBtu (steam) = 1.32 MBtu (coal)

Electricity Price Differential Cost = $\frac{-\$1.11}{\text{MBtu (steam)}}$ * 1 MBtu (steam) = -$1.11

<u>Example #2</u>

Calculate savings due to 1 MBtu reduction in 275 psig steam use.

Coal savings = 1.21 MBtu (coal)/MBtu (steam) * 1 MBtu (steam) = 1.21 MBtu (coal)

Electricity Price Differential Cost = $\frac{-\$0.35}{\text{MBtu (steam)}}$ * 1 MBtu (steam) = -$0.35

<u>Example #3</u>

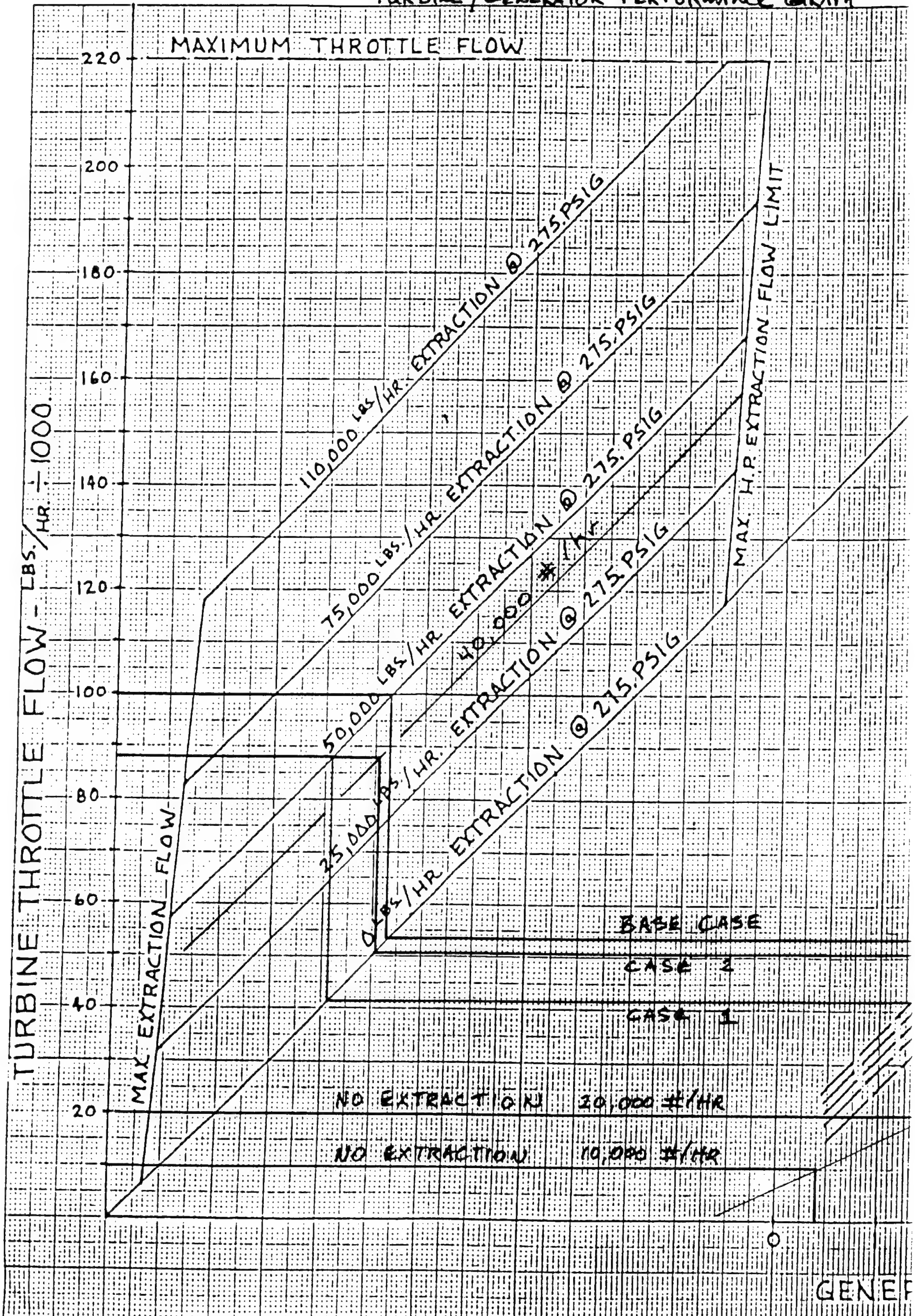
Value of Steam at Powerhouse #1:

Coal savings - electricity price differential costs

40 psig:	1.32 * 1.61 - 1.11	= $1.02/MBtu
275 psig:	1.21 * 1.61 - 0.35	= $1.60/MBtu

CURVE NO.

TURBINE / GENERATOR PERFORMANCE GRAPH



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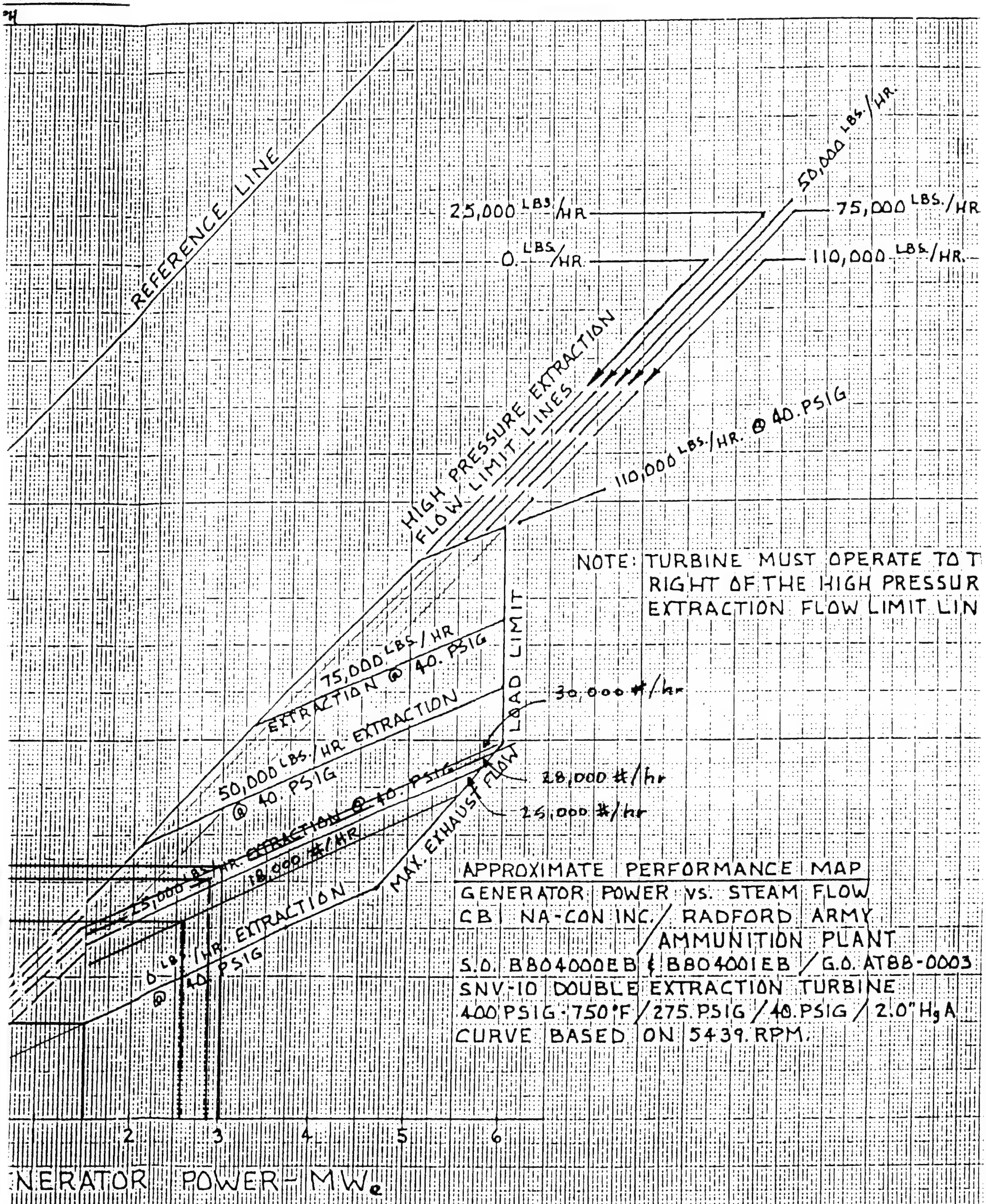
DATE 2/


REFERENCE LINE
25,000 LBS/HR
0 LBS/HR
50,000 LBS./HR.
75,000 LBS./HR
110,000 LBS./HR.
HIGH PRESSURE EXTRACTION FLOW LIMIT LINES
110,000 LBS./HR. @ 40. PSIG
NOTE: TURBINE MUST OPERATE TO T
RIGHT OF THE HIGH PRESSUR
EXTRACTION FLOW LIMIT LIN
LOAD LIMIT
75,000 LBS./HR EXTRACTION @ 40. PSIG
50,000 LBS./HR. EXTRACTION @ 40. PSIG
30,000 #/hr
28,000 #/hr
25,000 #/hr
MAX. EXHAUST FLOW
25,000 LBS/HR. EXTRACTION @ 40. PSIG
18,000 #/HR
0 LBS/HR. EXTRACTION @ 40 PSIG
APPROXIMATE PERFORMANCE MAP
GENERATOR POWER VS. STEAM FLOW
CB NA-CON INC. / RADFORD ARMY AMMUNITION PLANT
S.O. B804000EB & B804001EB / G.O. AT88-0003
SNV-10 DOUBLE EXTRACTION TURBINE
400 PSIG - 750°F / 275. PSIG / 40. PSIG / 2.0" Hg A
CURVE BASED ON 5439. RPM.
2
3
4
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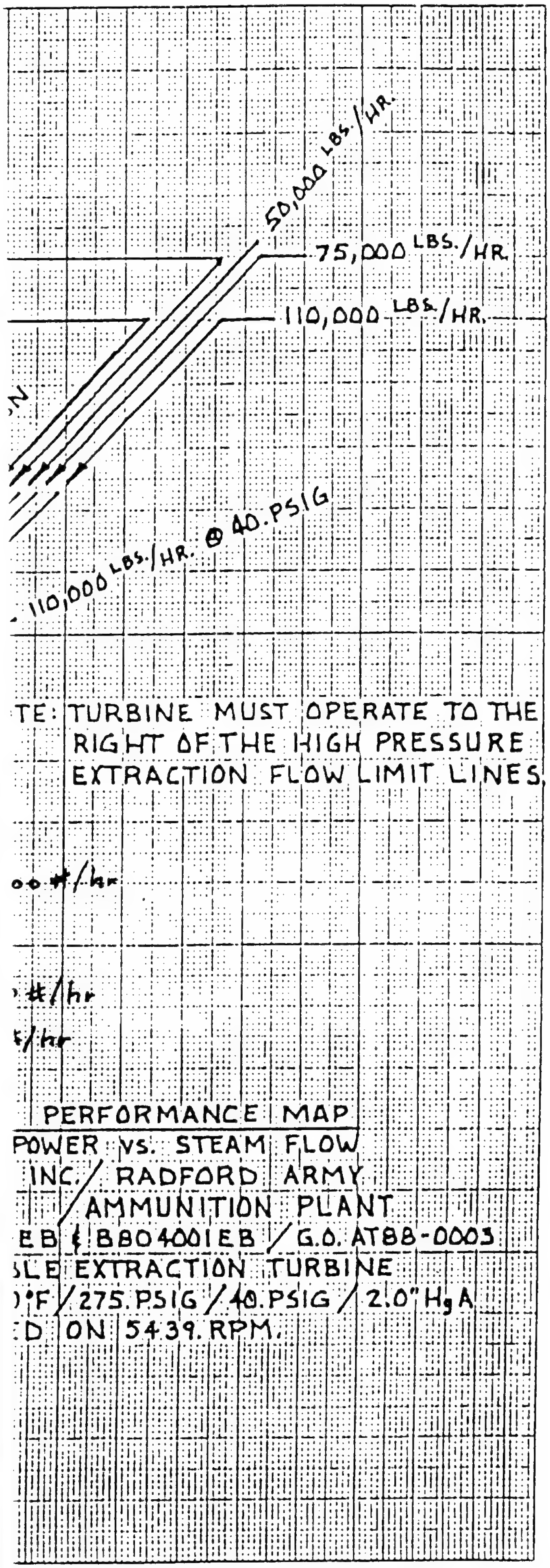
6
NERATOR POWER - MWe

DATE 2/18/88

2


50,000 LBS./HR.
75,000 LBS./HR.
110,000 LBS./HR.
110,000 LBS./HR. @ 40. PSIG
TE: TURBINE MUST OPERATE TO THE
RIGHT OF THE HIGH PRESSURE
EXTRACTION FLOW LIMIT LINES.
PERFORMANCE MAP
POWER VS. STEAM FLOW
INC./ RADFORD ARMY
/ AMMUNITION PLANT
EB & BB04001EB / G.O. AT88-0003
LE EXTRACTION TURBINE
°F / 275. PSIG / 40. PSIG / 2.0" Hg A
D ON 5439. RPM.

③

3/91

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SUBJECT ______________________ AEP NO ______

SHEET 1 OF 14

DESIGNER PA DATE 1/10/91

CHECKER ______________________ DATE ______

Heat Balance Calculations

Temperatures and pressures provided by RAAP

Throttle	:	400 psig	750°F	1389 Btu/lb
1st Ext	:	275 psig	684°F	1360 Btu/lb
2nd Ext	:	40 psig	440°F	1254 Btu/lb
Exhaust	:	2" Hga		calculated below

Typical operating conditions allow minimum flow to the condensing section. From the turbine/generator curves this would be 20,000 #/hr.

<u>Calculate exhaust enthalpy</u>

For 20,000#/hr throttle and no extractions, the power generated is 1500 kW (from the Turbine/Generator Performance Graph).

Therefore, assuming a 95% generator efficiency:

$$20{,}000\,\frac{(1389 - h)}{3413} * 0.95 = 1500$$

$$20{,}000 * 1389 - 20{,}000\,h = \frac{1500 * 3413}{0.95}$$

$$h = \frac{-\dfrac{1500 * 3413}{0.95} + 20{,}000 * 1389}{20{,}000}$$

$$h = \underline{\underline{1120}}\ \text{Btu/lb}$$

3/91

RS&H

SUBJECT ______________________

DESIGNER BA

CHECKER ______________________

AEP NO ______________________

DATE 1/10/91

DATE ______________________

Isentropic expansion (100% efficiency) from throttle to exhaust yields an enthalpy of 927 Btu/lb. From this efficiencies can be calculated for the various flow rates.

$$Eff = \frac{1389 - h}{1389 - 927} = \frac{1389 - h}{462}$$

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SUBJECT		AEP NO	
		SHEET	3 OF 14
DESIGNER	FFH	DATE	1/26/91
CHECKER		DATE	

Calculate effects of saving steam at point of load.

Assumptions: (provided by Hercules personnel)

- Boiler efficiency = 0.85
- Flow to condenser is 20,000 #/hr. (estimated)
- 275 psig return is 40% of production
- 40 psig return is zero
- 275 psig condensate return temp. is 60F
- Steam plant

	temp.	pressure		enthalpy
throttle	750F	415a	(400 psig)	1389
extraction 1	684F	290a	(275 psig)	1360
extraction 2	440F	55a	(40 psig)	1254
final ext.		2" Hg		

~~Steam~~

The purpose of these calculations are to show the coal savings due to a reduction in steam use and also the amount of electricity that must be purchased to make up for the reduction in on-site electricity as a result of the lowered steam production. The method used is to perform a heat balance for the Base Case or typical operating condition, and two other cases. Case 1 is for a 10,000 #/hr reduction in 40 psig steam. Case 2 is for a 10,000 #/hr reduction in 275 psig steam. Mass and energy balances are performed around the deaerator tank (DA). ~~and the~~ The turbine/generator performance curves are used to calculate the final extraction enthalpy. It is further assumed that a reduction in steam load at the point of use will result in a reduction in steam production.

- Calculate final exhaust enthalpy
- Use the turbine/generator performance graph with no extractions to get flow and power values
- Knowing the throttle flow enthalpy is 1389 Btu/lb (see assumptions) the exhaust enthalpy can be calculated

$$\dot{m} * \Delta h \cdot \eta_g = W_{T/G}$$

where $\dot{m}$ = mass flow rate (lb/hr)
Δh = difference between initial and final enthalpys (Btu/lb)
$W_{T/G}$ = work done by turbine/generator (Btu)
η_g = generator eff. (≈ 0.95)

Ex.: $20{,}000 \text{ lb/hr} \cdot (1389 - X) \text{ Btu/lb} \cdot 0.95 = 1500 \text{ kW} \cdot 3413 \frac{\text{Btu}}{\text{kW}}$

$$X = 1120 \text{ Btu/lb}$$

- Cost of electricity per kWh ≈

$$P_E = \frac{C \cdot \dot{m} \cdot \Delta h}{\eta_B \cdot E}$$

where C = coal price (\$/Btu)
η_B = boiler eff.
E = power produced (kW)
t = time (hr)

Ex.: $$\frac{1.61 (\$/\text{MBtu}) \left(\frac{\text{MBtu}}{10^6 \text{ Btu}}\right) (20{,}000 \text{ lbs/hr}) (1389 - 69) \text{ Btu/lb}}{0.85 \cdot 1500 \text{ kW}}$$

$$P_E = 3.3 \text{ ¢/kWh}$$

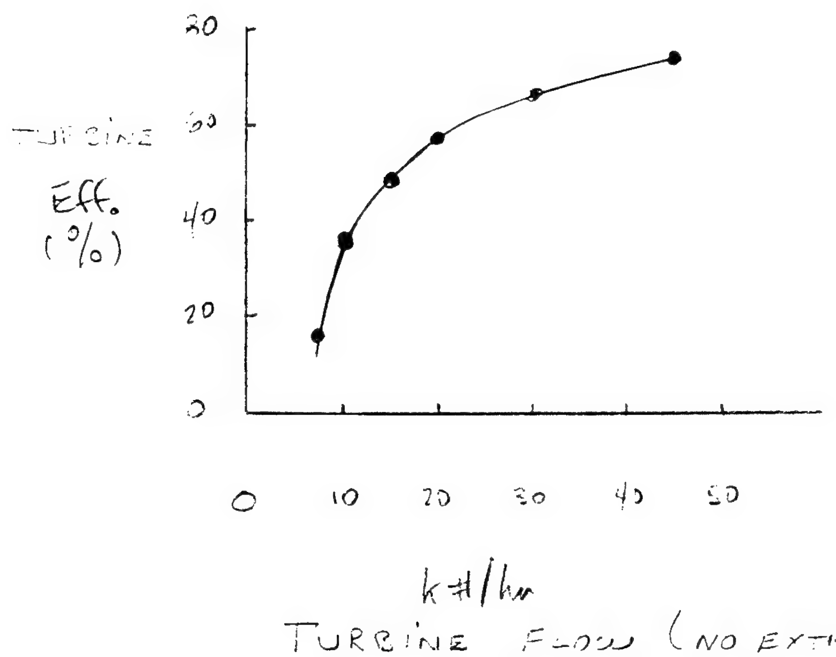
REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT Radford Turbine Efficiency
DESIGNER PAA
CHECKER

AEP NO 290-0379-000
SHEET 5 OF 14
DATE 9/20/90
DATE

The results of the previously described calculations are shown below:

k#/hr	TURBINE EXHAUST Enthalpy @ 2" HgA	Efficiency	kW	#/kwh
45	1046	74	4300	2.6
30	1078	67	2600	2.9
20	1120	58	1500	3.3
15	1161	49	950	3.9
10	1245	31	400	6.3
7.5	1317	16	150	12.5



BASE CASE (see accompanying diagram)

DA HEAT BALANCE

① $\Sigma m = 0$ $\qquad 20 + m_1 + m_2 + 20 - 100 = 0$

$$m_1 + m_2 =$$

$$m_2 = 60 - m_1$$

② $\Sigma E = 0$ $\qquad 20(28) + 28m_1 + m_2(1254) + 20(69) - 100(236) = 0$

SUBSTITUTING & REARRANGING

$$m_1 = \frac{100(236) - 20(69) - (20)(28) - (60)(1254)}{(28 - 1254)}$$

$$m_1 = 43.7 \text{ lbs/hr}$$

$$m_2 = 60 - 43.7 = 16.3 \text{ lbs/hr}$$

Power Production

$$0.95 * \frac{100(1389-1360) + 50(1360-1254) + 20(1254-1120)}{3413} = \underline{3028 \text{kW}}$$

HEAT INPUT

$$Q = \frac{m\Delta h}{\eta} = \frac{100(1389-236)}{.85} = 135{,}647 \text{ KBtu/Hr}$$

$$\underline{135.6 \text{ MBtu/hr}}$$

RS&H

SUBJECT RADFORD AAP

AEP NO

DESIGNER G. FALLON

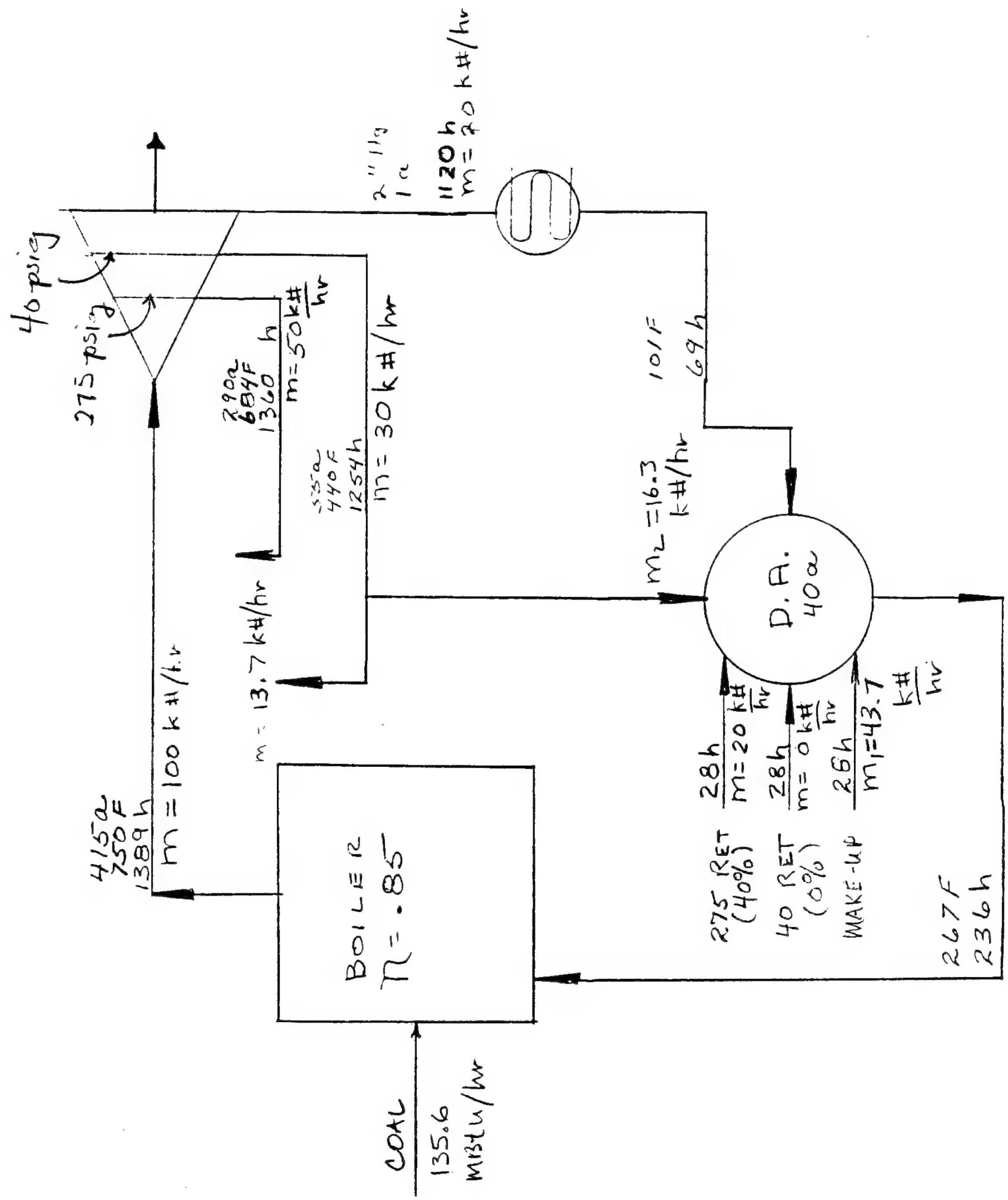
DATE 9-19-90

CHECKER JH

DATE

KW = 3028 kW

BASE CASE



RS&H®

SUBJECT ______

DESIGNER S.T.

CHECKER BA

AEP NO ______

SHEET 8 OF 14

DATE ______

DATE ______

CASE 1 REDUCE HOPSIA STEAM FLOW by 10,000 #/HR.
(see accompanying diagram)

D.A. HEAT BALANCE

① $\Sigma m = 0$ $$20 + m_1 + m_2 + 20 - 88 = 0$$
$$m_1 + m_2 = 48$$
$$m_2 = 48 - m_1$$

② $\Sigma E = 0$ $$42.5(98) + 10(98) + 28m_1 + 1254m_2 + 20(69) - 88(236) = 0$$

SUBSTITUTING & REARRANGING

$$m_1 = \frac{88(236) - 20(69) - (20)(28) - (48)(1254)}{(28 - 1254)}$$

$$m_1 = 33.7 \text{ lbs/hr}$$

$$m_2 = 14.3 \text{ lbs/hr}$$

POWER PRODUCTION

$$\frac{0.95 \times 88{,}000(1389-1360) + 38{,}000(1360-1254) + 20{,}000(1254-1120)}{3413} = \underline{\underline{2577 \text{ kW}}}$$

FUEL USE

$$Q = \frac{m \Delta h}{\eta} = \frac{88(1389 - 236)}{.85} = 119{,}369 \text{ KBTU/HR}$$

$$\underline{\underline{119.4 \text{ MBtu/hr}}}$$

RS&H®

SUBJECT: RADFORD AAP

AEP NO:

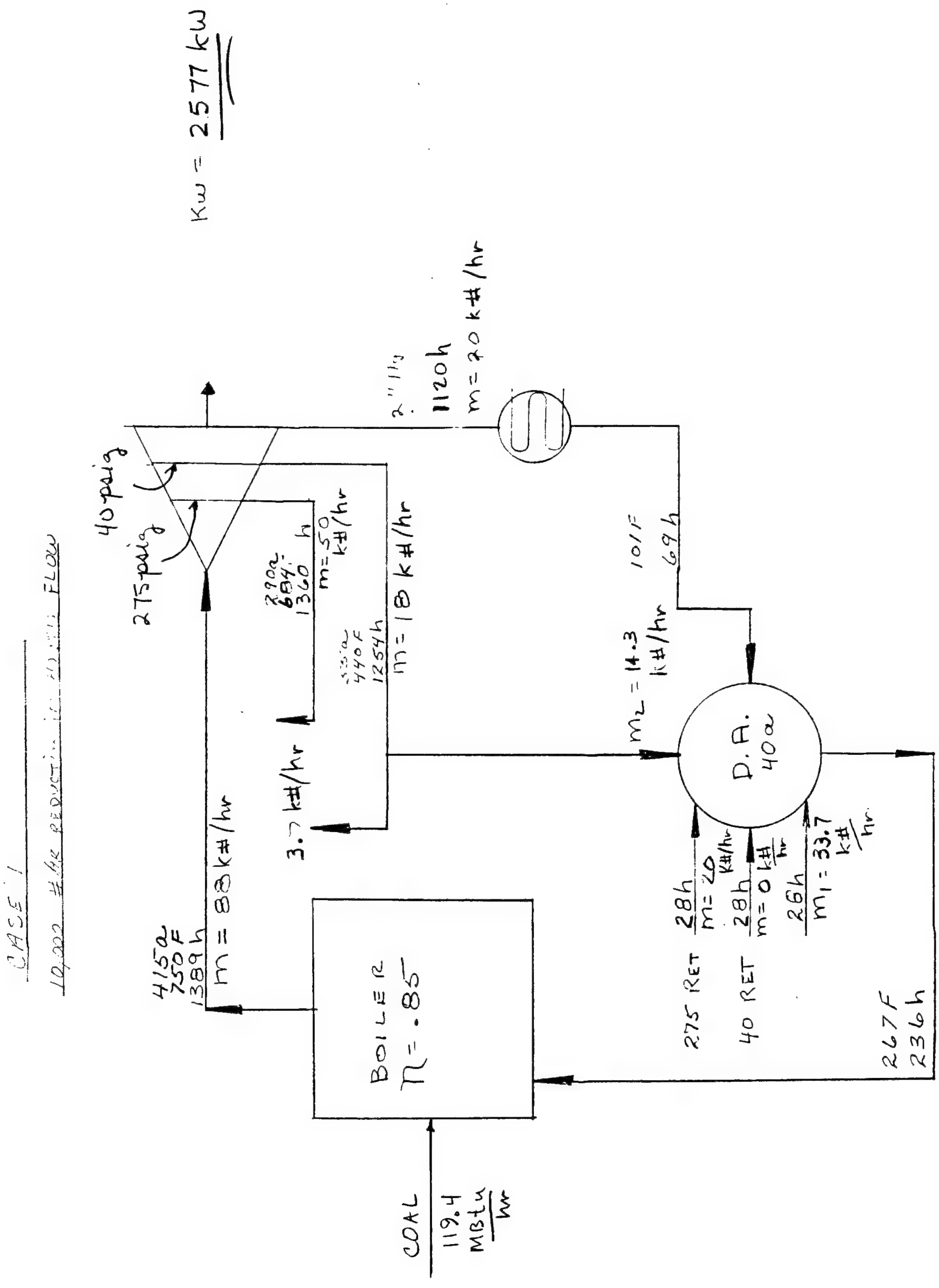
SHEET 9 OF 14

DESIGNER: G. FALLON

DATE: 9-19-90

CHECKER:

DATE:



3/91

CASE 2 10,000 #/HR REDUCTION IN 275 PSIG FLOW

D.A. HEAT BALANCE

① $\Sigma m = 0$ $$16 + m_1 + m_2 + 20 - 88 = 0$$
$$m_1 + m_2 = 52$$
$$m_2 = 52 - m_1$$

② $\Sigma E = 0$ $$(16)(28) + 28m_1 + 1254m_2 + 20(69) - 88(236) = 0$$

SUBSTITUTING & REARRANGING

$$m_1 = \frac{88(236) - 20(69) - (16)(28) - 52(1254)}{(28 - 1254)}$$

$$m_1 = 37.7 \text{ lb/hr}$$

$$m_2 = 52 - 37.7 = 14.3 \text{ lb/hr}$$

POWER PRODUCTION

$$\frac{0.95 * 38,000(1389-1360) + 48,000(1360-1254) + 20,000(1254-1120)}{3413}$$

$$= \underline{2873 \text{ kW}}$$

HEAT INPUT

$$Q = \frac{m \Delta h}{\eta} = \frac{88(1389 - 236)}{0.85} = \underline{119.4 \text{ MBtu/hr}}$$

RS&H®

SUBJECT: RADFORD AAP

DESIGNER: G. FALLON

CHECKER: TAH

AEP NO

SHEET 11 OF 14

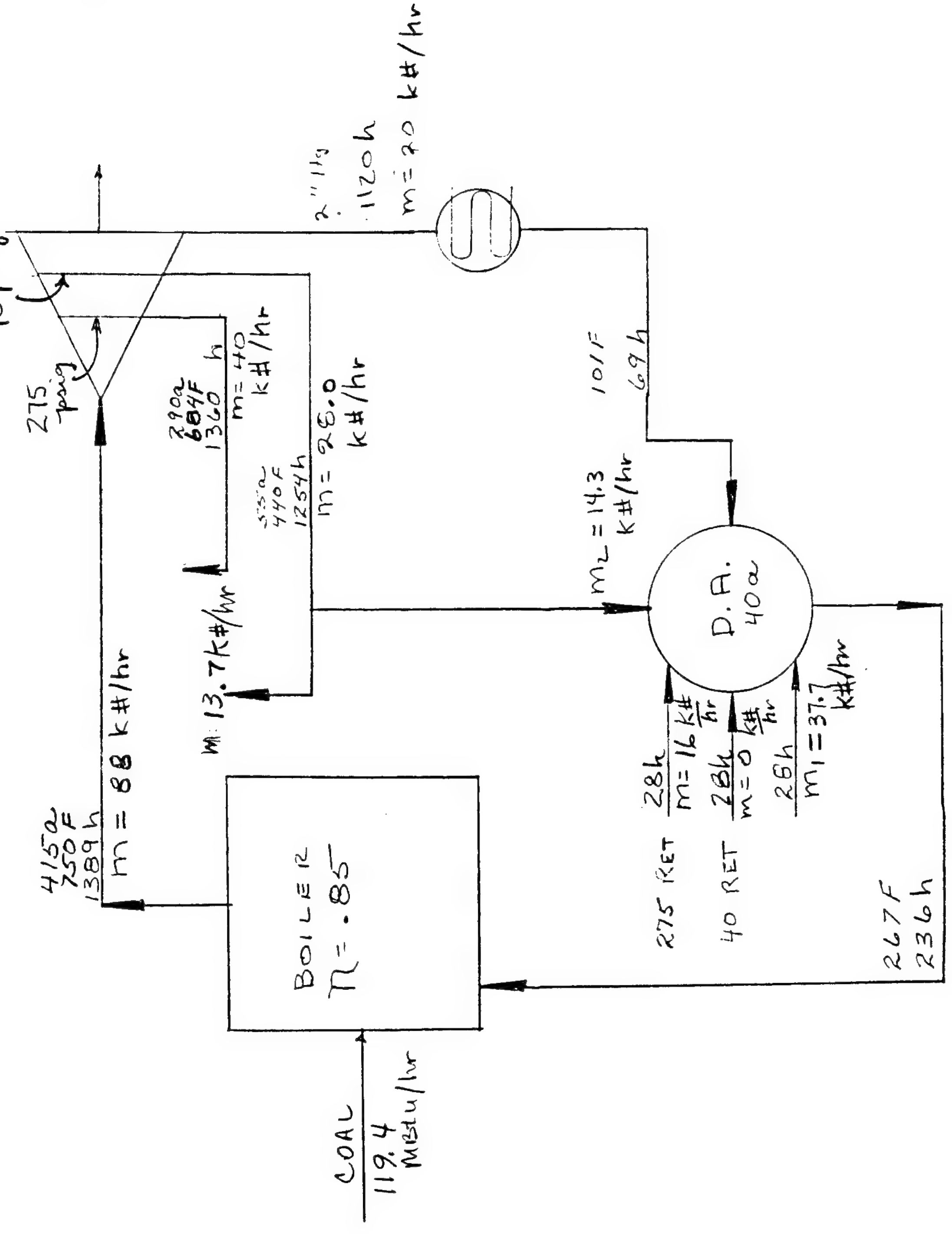
DATE 9-19-90

DATE

KW = 2873 kW

CASE 2

10,000 #/hr REDUCTION IN
275 PSIG EXTRACTION FLOW



CALCULATE ENERGY FUEL SAVINGS AND EFFECT OF REDUCED POWER GENERATION DUE TO SAVING 40 PSIG STEAM

REFERENCE : HEAT BALANCES (BASE CASE & CASE 1)

COAL SAVINGS PER MBtu OF 40 PSIG STEAM SAVED

$$\frac{(135.6\ \text{MBtu/hr} - 119.4\ \text{MBtu/hr})}{(10{,}000\ \#/\text{hr})(1254\text{h} - 28\text{h}) * \frac{\text{MBtu}}{10^6\ \text{Btu}}} = \underline{\underline{1.32}}\ \frac{\text{MBtu coal}}{\text{MBtu 40 PSIG STEAM}}$$

CALCULATE INCREASED COSTS INCURRED DUE TO PURCHASING ELECTRICITY RATHER THAN PRODUCING IT ON-SITE

$$\frac{(3028\ \text{kW} - 2577\ \text{kW}) * (0.03026\ \$/\text{kwh})}{(10{,}000\ \text{lb/hr})(1254\text{h} - 28\text{h})\ \text{Btu/lb}} =$$

$= \underline{\underline{\$1.11}}$ ADDITIONAL PURCHASED ELECTRICITY COSTS PER MBtu 40 PSIG STEAM SAVED

RS&H®

SUBJECT
AEP NO
SHEET 13 OF 14
DESIGNER GWF
DATE
CHECKER PAH
DATE

CALCULATE THE FUEL SAVINGS DUE TO 275 PSIG STEAM REDUCTION
275 PSIG SAVINGS FACTOR - USING HEAT BALANCES
(BASE CASE & CASE 2)

COAL SAVINGS PER MBTU OF 275 PSIG STEAM SAVED:

$$\frac{(135.6 - 119.4)\ \text{MBtu/hr}}{(10{,}000\ \#/\text{hr})(1360-28)\ h} = 1.21\ \text{MBTU}$$

$$= \underline{\underline{1.21}}\ \frac{\text{MBTU COAL SAVED}}{\text{MBTU 275 psig stm saved}}$$

CALCULATE ADDITIONAL COSTS INCURRED DUE TO PURCHASING ELECTRICITY RATHER THAN PRODUCING IT ON-SITE

$$= \frac{(3028 - 2873)\ \text{kW} * (0.03026\ \$/\text{kwh})}{(10{,}000\ \text{lb/hr})(1360-28)\ h}$$

= $\underline{\underline{\$\ 0.35}}$ ADDITIONAL PURCHASED ELECTRICITY COSTS PER MBTU 275 PSIG STEAM SAVED

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT

DESIGNER JH

CHECKER SF

AEP NO

DATE

DATE

CALCULATIONS SUMMARY

STEAM SAVINGS FACTORS

COAL SAVINGS

$\left(\frac{\text{MBtu COAL}}{\text{MBtu STEAM}} \right)$

40 PSIG : 1.32
275 PSIG : 1.21

ADDITIONAL COSTS ASSOCIATED WITH ELECTRICITY PURCHASE VERSUS GENERATION ($ / MBTU STEAM)

40 PSIG : $ 1.11
275 PSIG : $ 0.35

SCHEDULE I.P.
Industrial Power Service

AVAILABILITY OF SERVICE

This rate Schedule is available for industrial, railroad, or pipeline customers having capacity requirements equal to or greater than 7,500 KW. Service shall be delivered and measured at voltage levels which have been designated as primary distribution, subtransmission, or transmission voltages for service in the general area, but not less than 2.4 KV. Each customer shall contract for a definite amount of electrical capacity in kilowatts which shall be sufficient to meet the customer's normal maximum demand, but in no case shall the capacity contracted for be less than 7,500 KW. The Company shall not be required to supply capacity in excess of that for which the customer has contracted. Contracts shall be in multiples of 100 KW.

MONTHLY RATE

	DELIVERY VOLTAGE		
	Primary Distribution 2.4-40 KV ($)	Sub-Transmission 41-90 KV ($)	Transmission Above 90 KV ($)
Customer Charge	183.00/month	538.00/month	876.00/month
Demand Charge: Each KW of monthly billing demand	7.77/KW	7.12/KW	7.66/KW
Energy Charge: All Billing KWH	0.00184/KWH	0.00092/KWH	0.00068/KWH
Reactive Demand Charge: For each KVAR of lagging reactive demand in excess of 50% of the monthly billing demand	0.59/KVAR	0.59/KVAR	0.59/KVAR
Levelized Fuel Factor: All Billing KWH	0.01589/KWH	0.01589/KWH	0.01589/KWH

.01681

MEASUREMENT AND DETERMINATION OF DEMAND AND ENERGY

The billing demand in KW shall be taken each month as the highest single 30-minute integrated peak in KW as registered during the month by a demand meter or indicator, or, at the Company's option, as the highest registration of a thermal type demand meter or indicator, but the monthly billing demand so established shall in no event be less than 60% of the contract capacity of the customer, nor less than 7,500 KW.

The reactive demand in KVAR shall be taken each month as the highest single 30-minute integrated peak in KVAR as registered during the month by a demand meter or indicator, or, at the Company's option, as the highest registration of a thermal type demand meter or indicator.

Billing KWH shall be metered KWH, except, when the Company elects to measure energy at the secondary side of transformers owned by the customer, billing KWH shall be metered KWH multiplied by 1.04, billing KW shall be metered KW multiplied by 1.04, and billing KVAR shall be metered KVAR multiplied by 1.04.

EQUIPMENT SUPPLIED BY CUSTOMER

Customers who as of October 7, 1983, owned, operated and maintained all equipment and apparatus beyond the delivery point of service, were receiving equipment credit for such ownership, and whose service was supplied at a delivery voltage of 34,500 volts (primary delivery voltage) shall receive a credit of $0.51 per KW of monthly billing demand.

MINIMUM CHARGE

This Schedule is subject to a minimum monthly charge equal to the sum of the customer charge, demand charge, energy charge, reactive demand charge of the monthly rate, levelized fuel factor, and credits as determined under the clause "Equipment Supplied by Customer."

SCHEDULE I.P.
Industrial Power Service
(continued)

PAYMENT

Bills are due upon presentation. Any amount due and not received at the main or branch offices, or authorized collection agencies, of the Company within twenty (20) days of the bill preparation date shall be subject to a delayed payment charge of 1½%. This charge shall not be applicable to local consumer utility taxes.

TERM OF CONTRACT

Contracts under this Schedule will be made for an initial period of not less than two (2) years and shall continue thereafter until either party has given twelve (12) months written notice to the other of the intention to terminate the contract. The company will have the right to make contracts for initial periods longer than two (2) years.

SPECIAL TERMS AND CONDITIONS

See Terms and Conditions of Service.

SCHEDULE S.G.S.
(Small General Service)

AVAILABILITY OF SERVICE

Available for small general service customers with normal maximum electrical capacity requirements of less than 300 KW per month.

When a customer being served under this Schedule establishes or exceeds a normal maximum requirement of 300 KW per month, the customer will be placed on the appropriate rate Schedule and required to contract for such capacity requirements.

MONTHLY RATE

Customer Charge	$7.94	per month
Demand Charge All Over 2.5 KW of Billing Demand	$3.22	per KW
Energy Charge All Metered KWH	2.461¢	per KWH
Levelized Fuel Factor All Metered KWH	1.589¢ .0405	per KWH

DETERMINATION OF BILLING DEMAND

The billing demand in KW shall be taken each month as the highest registration of a 15-minute demand meter or indicator.

Industrial and coal mining customers having 10 KW or higher normal maximum demand shall contract for capacity sufficient to meet their normal maximum requirements in KW. Monthly billing demands of these customers shall not be less than 60% of contract capacity. Monthly billing demands will be rounded to the nearest tenth.

EQUIPMENT SUPPLIED BY CUSTOMER

When the customer owns, operates, and maintains the complete substation equipment, including any and all transformers and/or switches and/or other apparatus necessary for the customer to take his entire service at the primary voltage of the transmission or distribution line from which said customer is to receive service, a credit of $0.30 per KW of monthly billing demand will be applied to each monthly bill.

MINIMUM CHARGE

This Schedule is subject to a minimum monthly charge equal to the customer charge, plus such additional charges as are derived from application of the demand charge, energy charge, levelized fuel factor and, if applicable, equipment credits.

PAYMENT

Bills are due upon presentation. Any amount due and not received at the main or branch offices, or authorized collection agencies, of the Company within twenty (20) days of the bill preparation date shall be subject to a delayed payment charge of 1½%. This charge shall not be applicable to local consumer utility taxes.

TERM

Variable, but not less than one (1) year initial period and shall continue thereafter until either party has given sixty (60) days written notice to the other of the intention to terminate the contract.

SPECIAL TERMS AND CONDITIONS.

See Terms and Conditions of Service.

Appala 'an Power Company
PO BOX 2700 ROANOKE VA 24044

Account Number: H 2 611 94 66250 1 1

RECEIVED
OCT 26 1989
HERCULES INC.
RADFORD, VA.

HERCULES INC
RADFORD ARMY AMMUNITION PLANT
P O BOX 2
RADFORD VA 24141

261194662501 1 0343436870343436870

OCTOBER 1989

Please Return This Portion With Your Payment

Last Pay Date	After Last Pay Date Add	Pay This Amount
NOV 14	5,151.55	343,436.87

Meter Types
K - Kilowatt Hour
D - KW Demand
A - KVA Demand
R - RKVAH
V - KVAR Demand

Codes
E - Estimated
C - Meter Change
O - Off Peak

Account Number: (Please Use When You Call or Write)
2 611 94 66250 1 1
Service Address
HERCULES INC
RADFORD VA 24141

Revenue Month OCTOBER 1989 Schedule 393 IP SUB Office PULASKI

Service From	Service To	Type	Meter Number	Previous Readings	Present Readings	Meter Constant	Metered Usage	Voltage Constant
09-22	10-23	K	83322	02769	03324	21000.	11655000	
09-22	10-23	D	01665		3167.000	6.30	19952	
09-22	10-23	V	01665		1588.000	6.30	10004	

Contract Capacity	13,000
Billing KVAR RKVAH	28.0
Metered Demand	19,952
Power Factor	
Billing Demand	19,952
Metered KWH	11,655,000
Power Factor Constant	
Adjusted KWH	11,655,000
Voltage Ad. KWH	
Billing KWH	11,655,000

MONTHLY RATE BILLING	338,516.79
REACTIVE DEMAND @ .590	16.52
GROSS AMOUNT	338,533.31
TOTAL MONTHLY BILLING	338,533.31
LATE PAYMENT CHARGE	72.47
PREVIOUS BALANCE	4,831.09
TOTAL AMOUNT DUE	343,436.87

@ 7.12 $/KW
@ 0.01681 $/KWH

IF PAID AFTER NOV 14 ADD $5,151.55

AEP APPALACHIAN POWER

MAIL DATE 10-25-89

55896

COAL MARKETING CORP.

P. O. Box 734
ABINGDON, VIRGINIA 24210
(703) 628-4507

INVOICE

Hercules Incorporated
Radford Army Ammunition Plant
Radford, VA

SHIPPED TO: Pepper, VA

FOR PH No 1

[redacted]R NO.	MINE NAME	MINE #	INVOICE DATE	INVOICE NO.	SALESMAN
		576	10-23-89	2036	George Barker

DESCRIPTION	QUANTITY SHIPPED	PRICE PER TON	AMOUNT
SOU 76229	105.00	$25.68	$ 2,696.40
NW 14469	92.95		2,386.96
SOU 78469	99.10		2,544.89
SOU 76034	106.20		2,727.22
SOU 77190	99.50		2,555.16
NW 139419	98.15		2,520.49
NW 8942	96.60		2,480.69
SOU 360916	98.80		2,537.18
SOU 360913	96.55		2,479.40
NW 4402	93.45		2,399.80
NW 119799	90.90		2,334.31
NW 118425	94.55		2,428.04
NW 138726	95.45		2,451.16
NW 10173	90.45		2,322.76
NW 75591	83.60		2,146.85
NW 92959	94.00		2,413.92
NW 132898	95.50		2,452.44
NW 132303	94.30		2,421.62
NW 116381	93.05		2,389.52
NW 142009	97.55		2,505.08
NW 132913	92.50		2,375.40
NW 74668	78.85		2,024.87
NW 119793	91.55		2,351.00
NW 92796	93.55		2,402.36
NW 93220	95.35		2,448.59
NW 120232	93.70		2,406.22
NW 11910	95.10		2,442.17
NW 9105	97.00		2,490.96
NW 6572	100.25		2,574.42
NW 138706	100.85		2,589.83
NW 166672	98.75		2,535.90
SOU 360629	103.50		2,657.88
SOU 351004	102.60		2,634.77
SOU 360127	96.85		2,487.11
SOU 360769	98.90		2,539.75
SOU 76739	100.70		2,585.98
	3,455.65 tons	@ $25.68	$88,741.10

WOODRUFF COAL COMPANY

MAILING ADDRESS
POST OFFICE
BOX 190

MINERS AND SHIPPERS OF BITUMINOUS COAL SINCE 1910

KALAMAZOO, MICHIGAN 49005

INVOICE NO.
23893

For: P H #2

PHONE AREA CODE 616 343-5531

TERMS ALL BILLS DUE THE 20TH FOR COAL SHIPPED THE PRECEDING MONTH. SUBJECT TO 1% INTEREST. ANNUAL RATE OF 12%.

INVOICE DATE		YOUR ORDER NO.	ROUTE	OUR ORDER NO.
9-30-89		VT 23457	N/S	6032

SOLD TO
Hercules, Incorporated Attn: Acct. Pay.
Caller Service 1
Radford Army Ammunition Plant
Radford, VA 24141-0299

SHIP TO
Cowan, VA

CONTENTS 1¼ x ¼ stoker

DATE SHIPPED	CAR INITIAL	CAR NUMBER	POUNDS	DATE SHIPPED	CAR INITIAL	CAR NUMBER	POUNDS
20-89	N&W	6664	1734				
		143206	1777				
		7241	1732				

+ FRT AT 14.13 Ton

INVOICE TOTALS	CARS	POUNDS	TONS	PRICE	AMOUNT	PAY THIS AMOUNT
	3	5243	262.15	28.50	7,471.28	

AS USED HEREIN THE TERM "TON" MEANS A NET TON OF 2000 POUNDS.

RAILROAD WEIGHTS TO GOVERN ALL SETTLEMENTS.

UNITED CITIES GAS COMPANY

P.O. BOX 60 703-639-1661 ◀ ADDRESS INQUIRIES TO THIS ADDRESS
JOHNSON CITY TN 37601-006

DATE RENDERED 11/02/89

ACCOUNT NO 67-0020643-01

23

DUE DATE 11/20/89

AMOUNT DUE $10,656.18

RADFORD ARSENAL
% MS. ANN KING
BOX 1

RADFORD VA 24141

TOTAL PAYMENT $ ____________

PLEASE RETURN THIS PORTION WITH YOUR PAYMENT

BRING BOTH PORTIONS TO PAY IN PERSON

UNITED CITIES GAS COMPANY

RATE CLASS	METER READING DATE	DAYS	METER READINGS PREVIOUS	METER READINGS CURRENT	MULTIPLIER OF PRESS. FACTOR	BTU FACTOR	CCF THERMS	PURCHASED GAS ADJUSTMENT	AMOUNT
650-8	10/31	32	31569	32789	13.4603	1.000	16422	.2786	
650-8	10/31	32	33902	35055	13.2355	1.000	15261	.2786	1065618

RECEIVED
NOV 6 1989
HERCULES INC.
RADFORD, VA.

ACCOUNT NUMBER	SERVICE ADDRESS	DUE DATE	AMOUNT DUE	AMOUNT DUE
67002064301	R-114, BOX	11/20/89	1081602	$1065618
CUSTOMER COPY	RATES AVAILABLE IN OUR OFFICE UPON REQUEST	CUSTOMER COPY	AFTER DUE DATE	

1 ll cm ; 100000 btu

2.36 $/MBtu

31652 MBtu

2.4

52937

INVOICE

INVOICE DATE	INVOICE NO.	PAGE
10/12/89	15113	1

... And Equipment Co., Inc.

LIQUID ASPHALTS • HEATING OILS • GASOLINES
PETROLEUM PRODUCT TRANSPORTATION
P. O. BOX 12626
ROANOKE, VIRGINIA 24027-02626
PHONE (703) 345-8865

FED. ID# 54-0486527

002364-000

SOLD TO
HERCULES INC.
RADFORD ARMY AMMN. PLANT
P. O. BOX 1
RADFORD, VA 24141

SHIP TO
FUEL OIL ACCOUNT

VB02602

ORDER NO.	ORDER DATE	CUSTOMER NO.	SALESMAN	PURCHASE ORDER NO.	SHIP VIA	SHIP DATE	TERMS
784	10/12/89	2364		FO #2	No ship via	10/11/89	~~NET 30 DAYS~~ Net

QUANTITY ORDERED	UNIT	QTY. SHIPPED / QTY. BACK ORD.	ITEM NUMBER	ITEM DESCRIPTION	PRICE UNIT / ITEM DISCOUNT	UNIT PRICE / EXTENDED PRICE
7,192	GL	D/S	#2-TL	FUEL OIL #2 -TRAILER LOAD	HGL	59.95 4,311.60

RECEIVED
OCT 13 1989
HERCULES INC.
RADFORD, VA

ROAD TAXES Fed 0.00 State 0.00 Total 0.00

SALE AMOUNT	4,311.60
MISC. CHARGES	.00
FREIGHT	.00
SALES TAX	.00
TOTAL	4,311.60
PAYMENT REC'D.	
BALANCE DUE	

FINANCE CHARGE IS COMPUTED BY A "PERIODIC RATE" OF 1½ % PER MONTH (OR A MINIMUM CHARGE OF 50 CENTS PER MONTH ON BALANCES UNDER $50) WHICH IS AN ANNUAL PERCENTAGE RATE OF 18% APPLIED TO ALL CHARGES OR ITEMS WHICH HAVE BECOME MORE THAN 30 DAYS PAST DUE. FUEL OIL AND EQUIPMENT CO., INC. ROANOKE, VIRGINIA
PLEASE PAY FROM THIS INVOICE. NO STATEMENT WILL BE SUBMITTED UNLESS REQUESTED.

INVOICE

INVOICE DATE	INVOICE NO.	PAGE
11/02/89	42875	1

56245

WEBB'S OIL CORPORATION

P.O. BOX 7098
ROANOKE, VIRGINIA 24019-0098
(703) 362-3795

439130-005

SOLD TO
HERCULES AEROSPACE DIV
HERCULES INCORPORATED
RADFORD, VA 24141-0299

SHIP TO
HERCULES AEROSPACE DIV
HERCULES INCORPORATED
RADFORD
0/

ORDER NO.	ORDER DATE	CUSTOMER NO.	SALESMAN	PURCHASE ORDER NO.	SHIP VIA	SHIP DATE	TERMS
46187	11/01/89	439130		VL-02755	TRUCK	11/02/89	NET ~~10 DAYS~~

QUANTITY ORDERED	ORD. UNIT	QUANTITY SHIPPED	QUANTITY BACK ORD.	ITEM NO.	ITEM DESCRIPTION	UNIT PRICE	PRC. UNIT	EXTENDED PRICE
7237.0		7237.0		12	# 2 HEATING OIL	59.25	HG	4,287.92

F... ... 0.00 State 0.00 Total 0.00

THANK YOU FOR YOUR ORDER

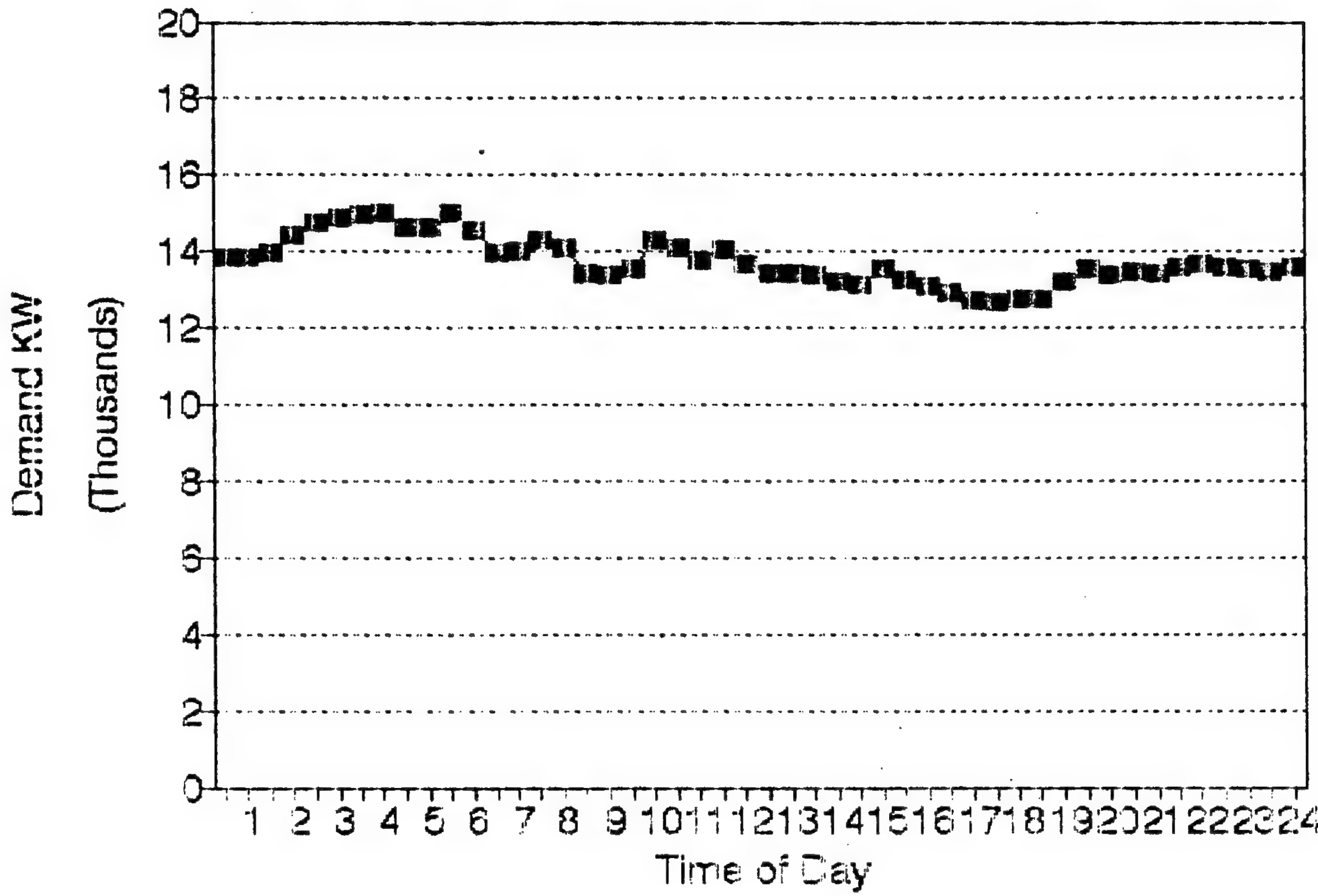
SALE AMOUNT	4,287.92
MISC. CHARGES	.00
SALES TAX	.00
FREIGHT	.00
TOTAL	4,287.92
PAYMENT REC'D	

Terms NET 10 DAYS Due date 11/12/89

RECEIVED NOV 6 1989 HERCULES INC. RADFORD, VA.

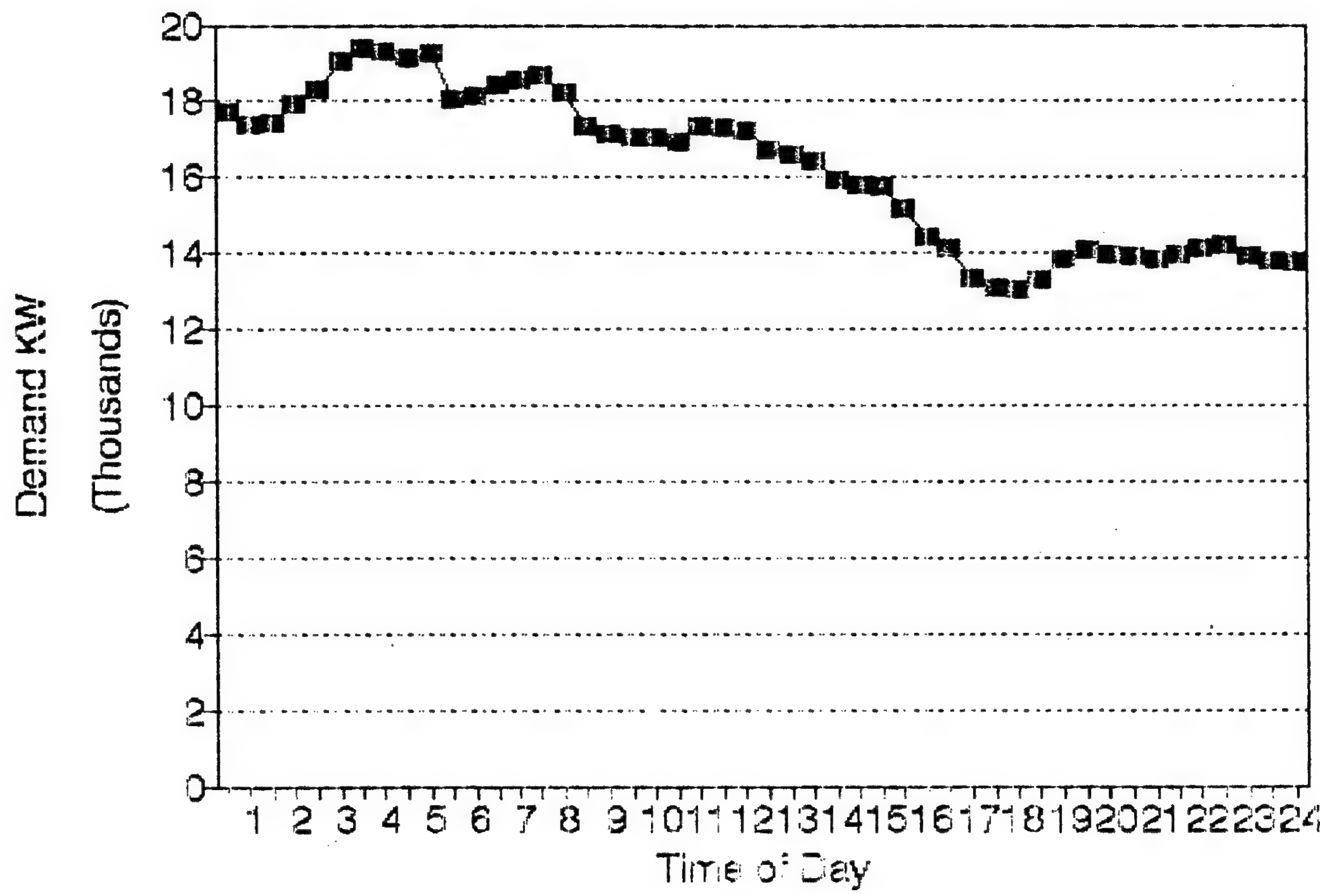
Radford AAP Electric Demand

Sunday - November 5, 1989



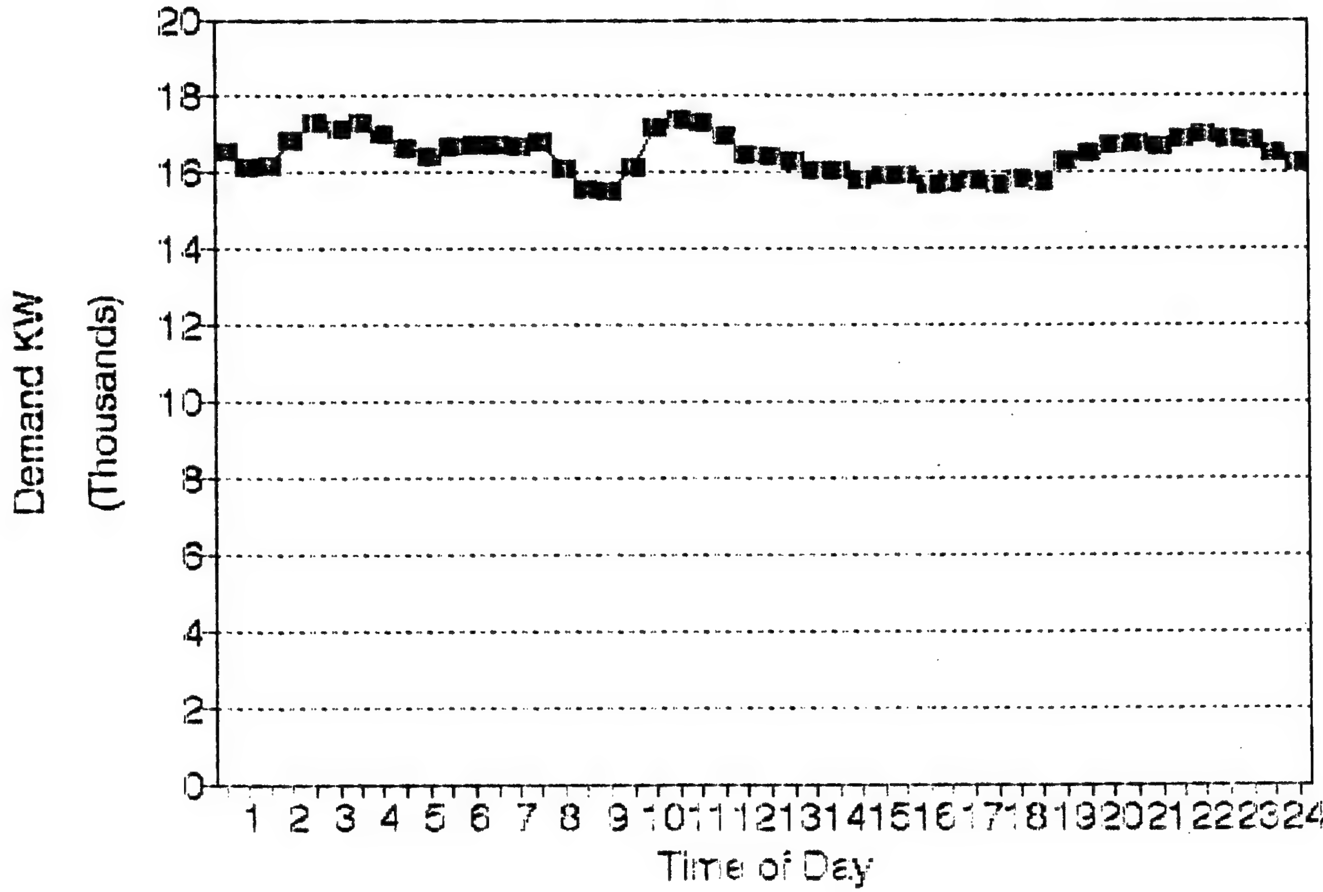
Radford AAP Electric Demand

Saturday - November 4, 1989



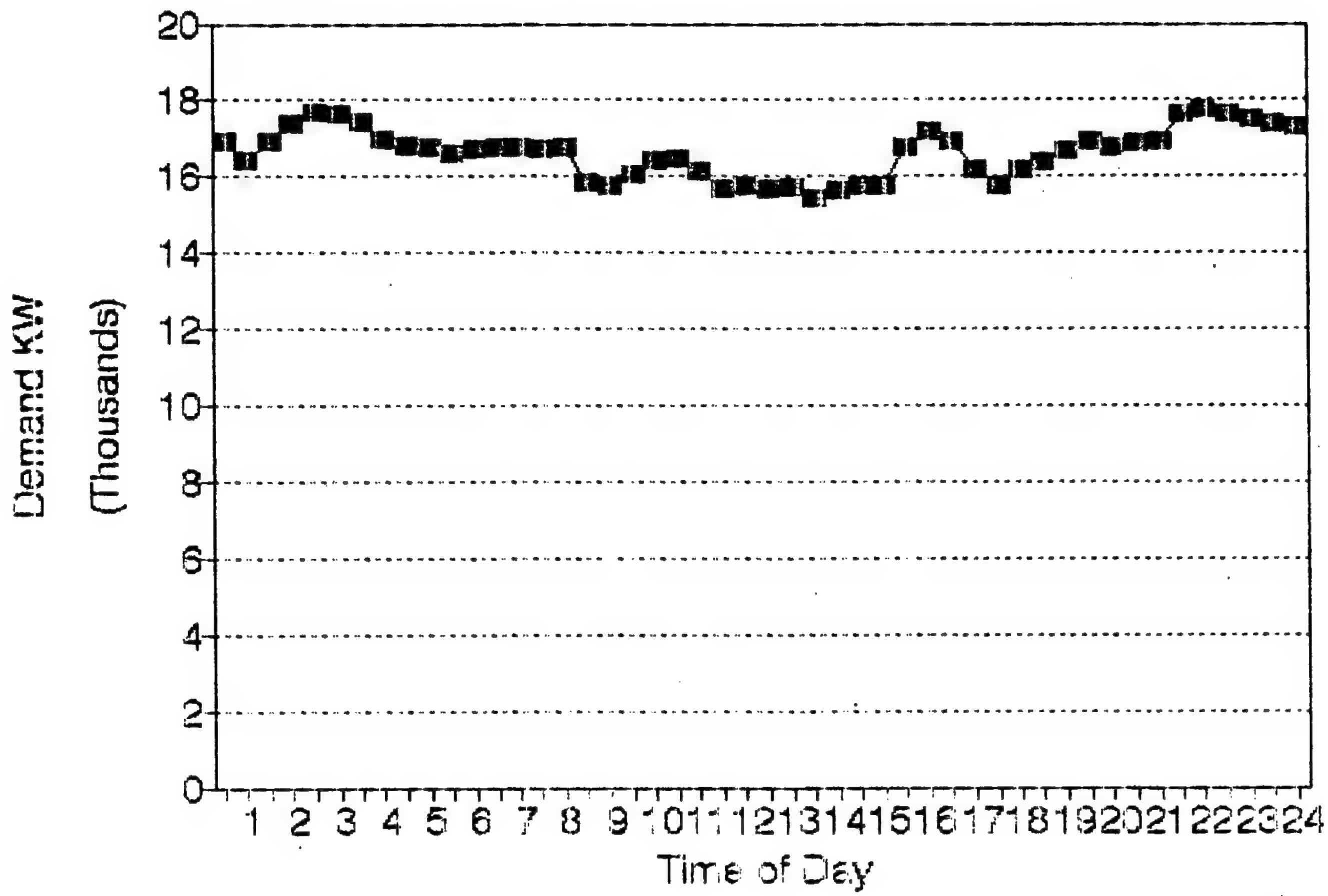
Radford AAP Electric Demand

Friday - November 10, 1989



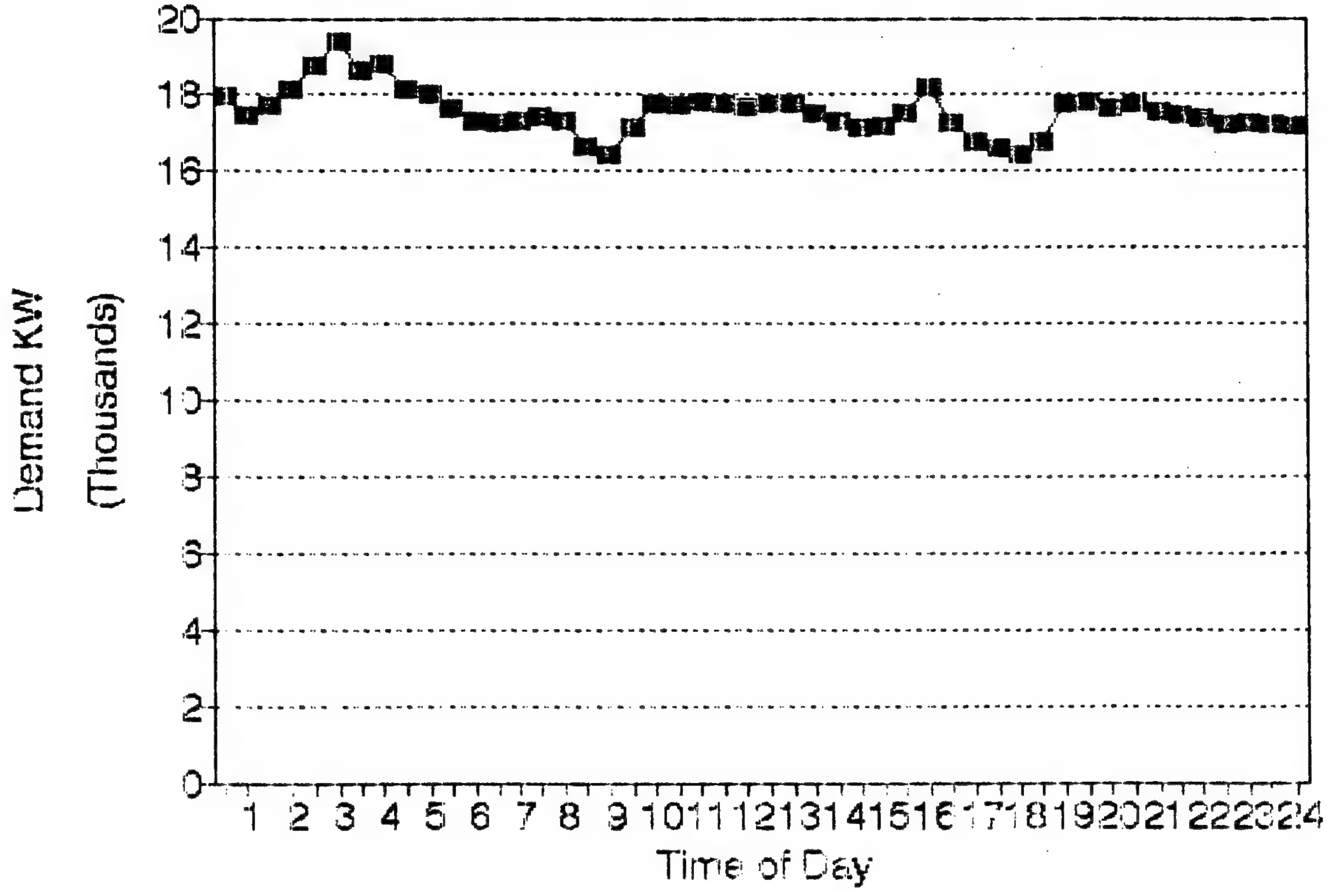
Radford AAP Electric Demand

Thursday - November 9, 1989



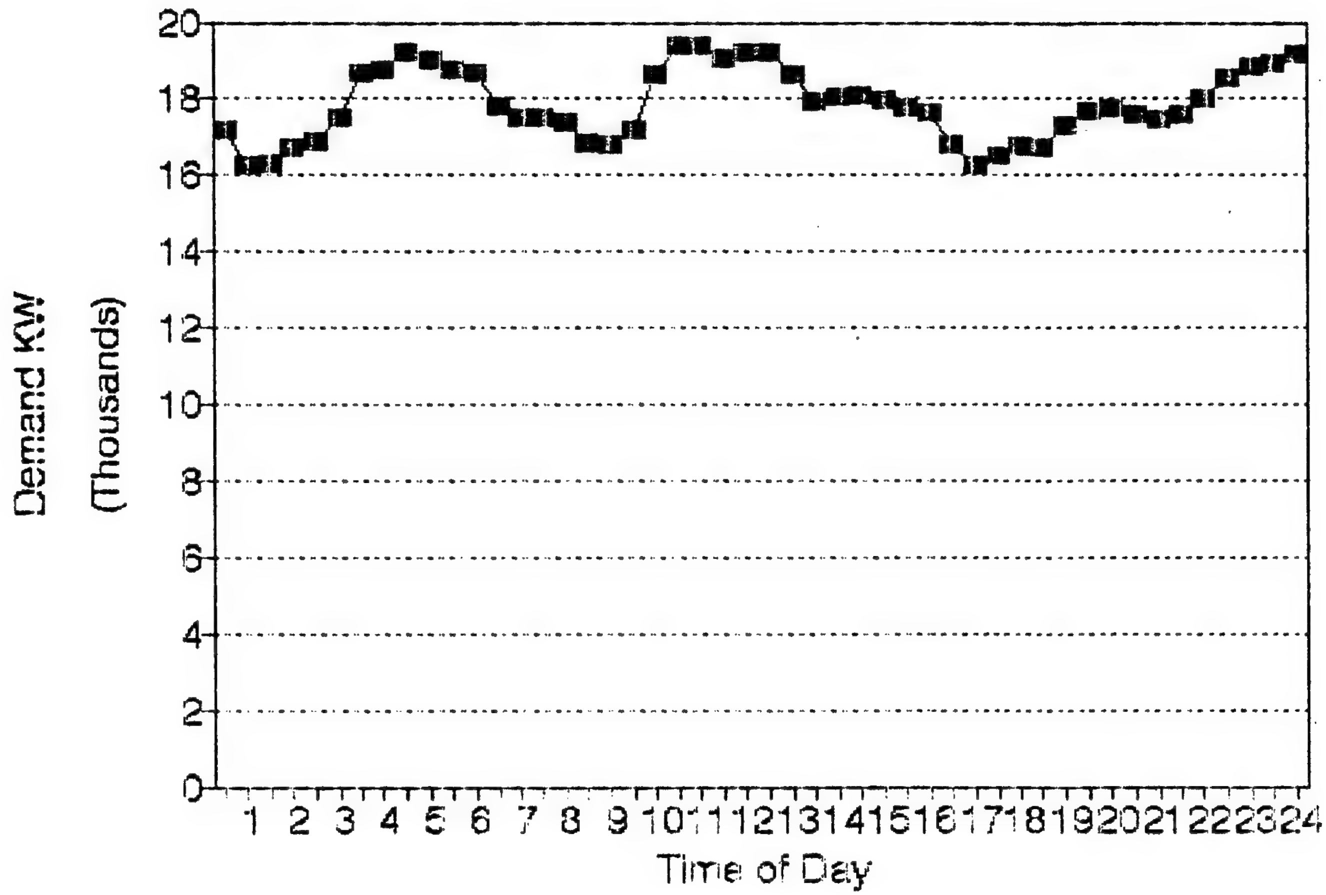
Radford AAP Electric Demand

Wednesday - November 8, 1989



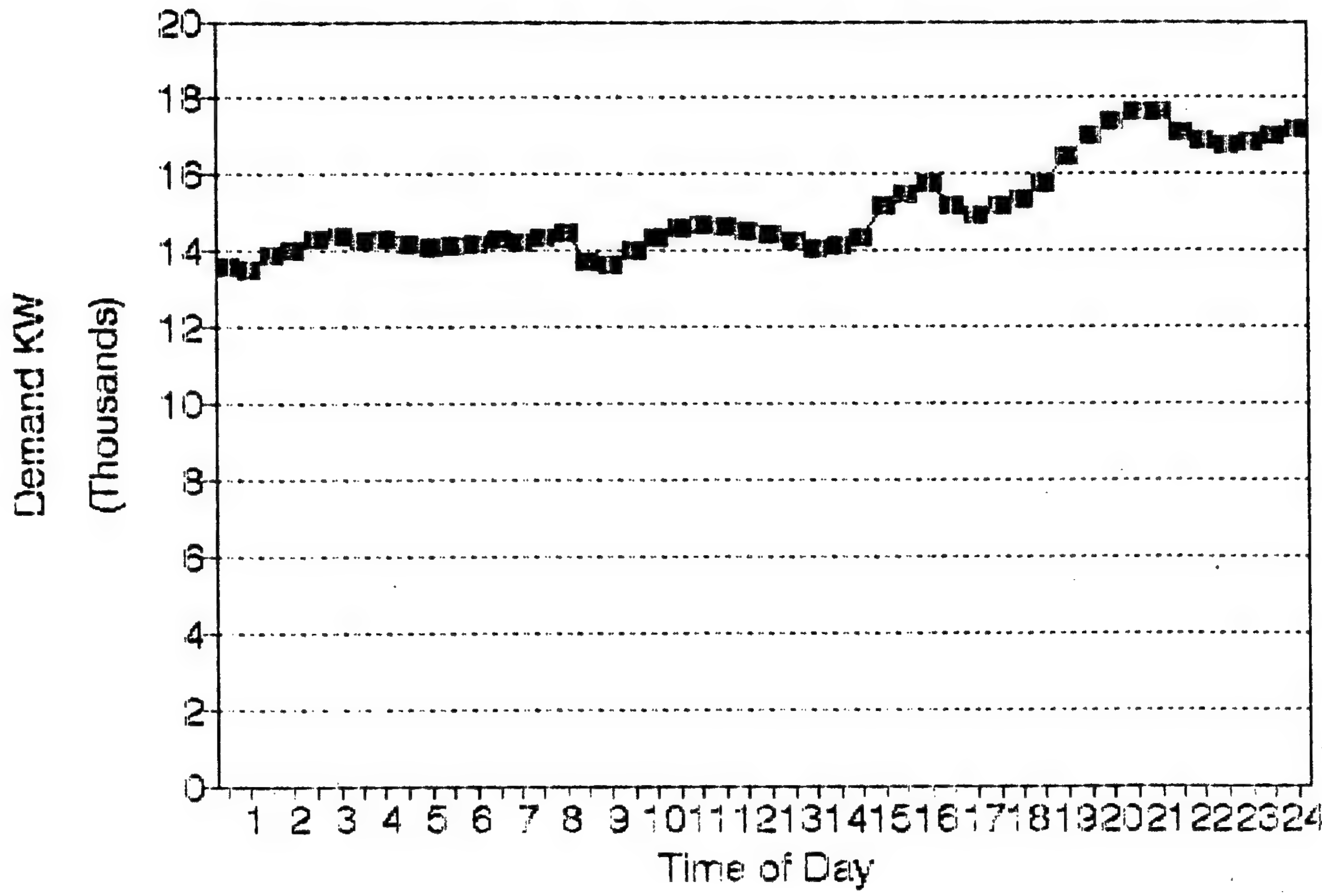
Radford AAP Electric Demand

Tuesday - November 7, 1989



Radford AAP Electric Demand

Monday - November 6, 1989



ENERGY DISTRIBUTION ANALYSIS BACKUP

ELECTRICITY	SUMMER (1/89)	WINTER (8/89)	AVERAGE	%	ASSIGNED AREA
PH#1	1,070,000	1,517,000	1,293,500	9.9	UTIL
BUS LOSS	227,850	595,550	411,700	3.1	UTIL
CAST PROP	546,590	576,580	561,585	4.3	S'LESS
SOLVENT	2,440,031	2,170,701	2,305,366	17.6	SOLVENT
SOLVENTLESS	1,702,616	1,885,691	1,794,154	13.7	S'LESS
NG	178,542	349,109	263,826	2.0	OTHER
ACID	1,660,940	1,200,914	1,430,927	10.9	ACID/NC
NC	2,296,520	1,213,374	1,754,947	13.4	ACID/NC
TNT	10,800	9,600	10,200	0.1	OTHER
WASTE ACID	204,575	201,737	203,156	1.6	ACID/NC
PLANT WATER	721,000	800,000	760,500	5.8	UTIL
CAST WATER	61,295	102,960	82,128	0.6	UTIL
PLANT AIR	420,480	386,880	403,680	3.1	UTIL
PH #2	129,759	216,948	173,354	1.3	UTIL
ASBP	1,146,000	333,240	739,620	5.6	ADM/HEAT
AMBP	741,000	15,000	378,000	2.9	ADM/HEAT
HOUSING	18,490	23,624	21,057	0.2	ADM/HEAT
OTHERS	216,800	222,160	219,480	1.7	OTHER
INDIRECT	359,712	234,932	297,322	2.3	OTHER

3/91

DF8001 RUN DATE 01/30/89
RADF[illegible] ARMY AMMUNITION PLANT
ELEC[illegible]IC POWER DISTRIBUTION
JANUARY, 1989

DISTRIBUTED POW[illegible]SAGE

E Engr. [illegible]

POWER HOUSE GENERATION	KWH	
GENERATOR NO 1	0	
GENERATOR NO 2	2,543,000	
GENERATOR NO 3	2,695,000	
GENERATOR NO 4	2,954,000	
TOTAL GENERATION	8,192,000	
POWER HOUSE USAGE	1,517,000	12.6
NET GENERATION	6,675,000	
PURCHASED POWER-APCO	3,864,000	
TOTAL GEN+PURCH POWER	12,056,000	
GENERATED PEAK DEMAND	20,600	
PURCHASED PEAK DEMAND	1,400	
TOTAL PEAK DEMAND	22,000	
DATE 01/09/89 TIME 2000 HRS		
AVERAGE MONTHLY KW	17,940	

POWER HOUSE DISTRIBUTION

CKT	NAME	PANEL	KWH
15	FLOODLTG	2	142,900
14	LIGHTING	3	213,000
5	SHOPS	4	130,300
7	A PROPEL	8	346,000
1	A JORDAN	9	130,000
3	A NITROC	10	87,000
8	B PROPEL	22	616,000
4	B NITROC	23	148,000
2	B JORDAN	24	106,000
6	ACID PLT	25	586,000
10-13	WATERWKS	26	560,000
9	C PROPEL	27	967,000
11	LIGHTING	28	614,000
12	C NITROC	29	351,000
16-17	ADM AREA	39	973,000
SUBTOTAL PWR HSE DIST			5,970,200

69KV LOOP DISTRIBUTION

			KWH	
33	TNT	433	755,000	
34	1RP	434	842,250	
35	PUMP	435	240,000	
36	CAST	436	1,554,000	
37	4RP	437	0	
39	ASBP	439	567,000	
40	AMBP	461	15,000	
SUBTOTAL LOOP DIST.			3,973,250	
TOTAL POWER DIST.			9,943,450 ←	
BUS LOSS			595,550	4.9

PLANT:

ACCOUNT	KWH		%
CAST PROPELLANT	576,580		4.7
SOLVENT PROPELLANT	2,170,701		18.0
SOLVENTLESS PROPELLANT	1,885,691		15.6
NITROGLYCERIN	349,109		2.9
ACID	1,200,914		10.0
NITROCELLULOSE	1,213,374		10.1
TNT	~~[illegible]~~	9,600	—
WASTE ACID PLANT	201,737		1.7
PLANT WATER	800,000		6.6
CAST WATER	102,960		1.0
PLANT AIR	386,880		3.2
CAST AIR	0		—
POWER HOUSE 2	216,948		1.8
ASBP	~~[illegible]~~	333,240	2.8
AMBP	15,000		0.1
TOTAL PLANT USAGE	9,462,734		

OTHERS:

ACCOUNT	KWH	%
STAFF VILLAGE		
HOUSE NO 1	726	
HOUSE NO 2	1,447	
HOUSE NO 3	1,089	
HOUSE NO 4	1,920	
HOUSE NO 5	1,259	
HOUSE NO 6	976	
HOUSE NO 7	2,057	
HOUSE NO 8	1,125	
HOUSE NO 9	936	
HOUSE NO 10	1,473	
HOUSE NO 11	847	
HOUSE NO 12	1,480	
HOUSE NO 13	2,002	
HOUSE NO 14	775	
HOUSE NO 15	516	
HOUSE NO 16	908	
HOUSE NO 17	772	
HOUSE NO 18	1,658	
HOUSE NO 19	659	
HOUSE NO 20	999	
TOTAL STAFF VILLAGE	23,624	0.2
RDAISA 450	215,000	1.8
AT&T	1,400	—
CORPS OF ENGINEERS	5,760	—
CENTEX (CONTRACTOR)	0	
TOTAL OTHERS USAGE	245,784	
TOTAL METERED USAGE	9,708,518	
INDIRECT USAGE	234,932	1.9

PRODUCT R[illegible] DATE 08/30/88
RADFORD ARMY AMMUNITION PLANT
ELECT[illegible] POWER DISTRIBUTION
AUGUST, 1988

DISTRIBUTED POWER [illegible]AGE

POWER HOUSE GENERATION	KWH	S	W	AVG
GENERATOR NO 1	2,289,000			
GENERATOR NO 2	2,213,000			
GENERATOR NO 3	768,000			
GENERATOR NO 4	0			
TOTAL GENERATION	5,270,000			
POWER HOUSE USAGE	1,070,000	7.6	12.9	10.3
NET GENERATION	4,200,000			
PURCHASED POWER-APCO	8,883,000			
TOTAL GEN+PURCH POWER	14,153,000			
GENERATED PEAK DEMAND	11,700			
PURCHASED PEAK DEMAND	12,900			
TOTAL PEAK DEMAND	24,600			
DATE 08/22/88 TIME 2100 HRS				
AVERAGE MONTHLY KW	21,061			

POWER HOUSE DISTRIBUTION

CKT	NAME	PANEL	KWH
15	FLOODLTG	2	102,700
14	LIGHTING	3	179,000
5	SHOPS	4	158,200
7	A PROPEL	8	317,000
1	A JORDAN	9	163,000
3	A NITROC	10	68,000
8	B PROPEL	22	749,000
4	B NITROC	23	228,000
2	B JORDAN	24	231,000
6	ACID PLT	25	2,060,000
10-13	WATERWKS	26	433,000
9	C PROPEL	27	1,180,000
11	LIGHTING	28	531,000
12	C NITROC	29	1,194,000
16-17	ADM AREA	39	0
SUBTOTAL PWR HSE DIST			7,593,900

69KV LOOP DISTRIBUTION

33	TNT	433	926,000
34	1RP	434	767,250
35	PUMP	435	288,000
36	CAST	436	1,227,000
37	4PP	437	0
39	ASBP	439	1,312,000
40	AMBP	461	741,000
SUBTOTAL LOOP DIST.			5,261,250
TOTAL POWER DIST.			12,855,150
BUS LOSS			227,850

PLANT: ACCOUNT	KWH		Sum %	Winter %	Avg %
CAST PROPELLANT	546,590		3.9	4.7	4.3
SOLVENT PROPELLANT	2,440,031		17.2	18.0	17.6
SOLVENTLESS PROPELLANT	~~[illegible]~~	1,702,616.	12.0	15.6	13.8
NITROGLYCERIN	178,542		1.3	2.9	2.1
ACID	1,660,940		11.7	10.0	10.9
NITROCELLULOSE	2,296,520		16.2	10.1	13.2
TNT	~~[illegible]~~	10,800.	–	–	–
WASTE ACID PLANT	204,575		1.4	1.7	1.6
PLANT WATER	721,000		5.1	6.6	5.9
CAST WATER	61,295		0.4	1.0	0.7
PLANT AIR	420,480		3.0	3.2	3.1
CAST AIR	0		–	–	–
POWER HOUSE 2	129,759		0.9	1.8	1.3
ASBP	1,146,000		0.8	2.8	1.8
AMBP	741,000		5.2	0.1	2.7
TOTAL PLANT USAGE	12,260,148				

OTHERS:

STAFF VILLAGE	KWH	Sum %	Winter %	Avg %
HOUSE NO 1	858			
HOUSE NO 2	567	4,200,000		
HOUSE NO 3	865			
HOUSE NO 4	727			
HOUSE NO 5	1,185			
HOUSE NO 6	632			
HOUSE NO 7	1,639			
HOUSE NO 8	142			
HOUSE NO 9	532			
HOUSE NO 10	1,057			
HOUSE NO 11	780			
HOUSE NO 12	1,070			
HOUSE NO 13	1,399			
HOUSE NO 14	1,843			
HOUSE NO 15	553			
HOUSE NO 16	797			
HOUSE NO 17	825			
HOUSE NO 18	1,852			
HOUSE NO 19	1,167			
HOUSE NO 20	600			
TOTAL STAFF VILLAGE	18,490	0.1	0.2	0.2
RDAISA 450	209,800	1.5	1.8	1.6
AT&T	1,400			
CORPS OF ENGINEERS	5,600			
CENTEX (CONTRACTOR)	0			
TOTAL OTHERS USAGE	235,290			
TOTAL METERED USAGE	12,495,438			
1.6 4.9 3.3 INDIRECT USAGE	359,712	2.5	1.9	2.2

COAL - PH#1	PEAK(#1) (#/HR)	HRS/MO	TOTAL (MBTU/YR)	% OF TOTAL	ASSIGNED AREAS
ELECTRICITY GENERATION	-	-	599,111 (#2)	16.5	UTIL
AOP	10,720	400	39,256	1.3	ACID/NC
NAC/SAC (2)	68,797	700	440,874	14.5	ACID/NC
COTTON DRY (1)	3,224	700	20,660	0.7	ACID/NC
NITRATOR (1)	42,368	960	372,354	12.2	ACID/NC
BOILING TUBS (1 HOUSE)	-	-	115,394 (#3)	3.8	ACID/NC
POACHER/BLENDER (1 HOUSE)	-	-	61,544 (#3)	2.0	ACID/NC
DEHY (2)	1,092	720	7,198	0.2	SOLVENT
MIX HOUSES (5)	5,060	720	33,353	1.1	SOLVENT
VERTICAL PRES/CUT (4)	16,844	720	111,026	3.7	SOLVENT
HORIZONTAL PRESS/CUT (2)	7,246	720	47,762	1.6	SOLVENT
SOLVENT RECOVERY (7)	8,196	720	54,023	1.8	SOLVENT
WATER DRY (6)	16,740	720	110,341	3.6	SOLVENT
OPEN AIR DRY TANK BLDGS (4)					
BLDG (2)	9,504	360	31,322	1.0	SOLVENT
BLDG (2)	7,564	720	49,858	1.6	SOLVENT
ACTIVATED CARBON RECOVERY (2)	26,832	720	176,861	5.8	SOLVENT
ETHER STILL (1)	11,986	720	79,005	2.6	SOLVENT
CAUSTIC SCREEN (1)	655	720	4,317	0.1	OTHER
4TH R.P. (ALL)	38,754	720	255,444	8.4	S'LESS
1ST R.P./FINISHING/CURING/ETC.	35,094	720	231,320	7.6	S'LESS
PASTE AIR DRY HOUSES (3)	3,486	720	22,978	0.8	S'LESS
CASBL BLDG HEAT	5,561	-	6,700 (#4)	0.2	ADM/HEAT
COMFORT HEAT	74,865	-	90,500 (#4)	3.0	ADM/HEAT
		TOT	2,961,202		
		ACT	2,961,202		

COAL - PH#2					
FAD BLDGS					
HEAT CYCLE (5)	32,520	720	192,121	6.3	S'LESS
TEMP. CONTROL (5)	13,809	720	81,581	2.7	S'LESS
NG#2	23,547	720	139,111	4.6	OTHER
SMALL GRAIN CURING (6)	16,410	720	96,947	3.2	S'LESS
CONDITIONING BLDGS (5)	20,180	720	119,219	3.9	S'LESS
CONING/SLEEVE/PACK-OUT/#4925	817	720	4,827	0.2	S'LESS
SOLVENTLESS PRESS (3)	4,983	720	29,439	1.0	S'LESS
COMFORT HEAT	20,180		14,500 (#4)	0.5	ADM/HEAT
		SUM	677,744		
		ACT	677,744		

TOTAL	3,638,946	
ACT	3,638,946	
TOTAL LESS ELEC GENERATION	3,039,835	100.0 (EXCLUDING ELEC GENERATION)

(#1) HERCULES STEAM ESTIMATES
(#2) PH1 POWER GENERATION AT 29% EFFICIENCY
(#3) BASED ON 1408 #/HR, 1175 BTU/LB,930 CYCLES/YR (ECO NC-X-1), & 75 HRS/CYCLE
(#4) CALCULATED USING BIN TEMPERATURE METHOD

3/91

1989

~~PEACETIME~~ STEAM REQUIREMENTS FOR PH-1

Ref: Hercules letter to COR (87-824-52) dated June 29, 1987.

Steam requirements based upon Proposed Production Schedule dated March 16, 1987 for production levels in November 1989, an ambient temperature of 0 degrees F, 28.7% Powerhouse 1 internal steam usage and 15% line losses.

AREA LINE OR FACILITY	COMMENTS	PEAK GENERATED POUNDS OF STEAM PER HOUR	Appx. Monthly Hours Use
Oleum Plant Start-Up and Sulfur Storage Tanks	Not Required on a continuous basis, therefore net export of 43,000 lbs. of steam per hr can not be considered to reduce peak steam requirements	838	-0-
Old Ammonia Oxidation Plant (AOP)	Modern AOP not in operation.	10,720	40
One NAC/SAC No. 735-2	2 NAC/SAC	68,797 m	70
One Cotton Dry House		3,224	70
One Improved Nitrator	(C Line - 480 hrs + 480 hrs for B Line)	42,368	96
One Boiling Tub House	Three tubs on heat build-up 79 Tubs/Mo / 3 ~~3~~ x 9,984 X __ hrs =	29,952	
	Six tubs on boil cycle 79/6 ~~6~~ x 2,475 X __ hrs =	14,850	

1989 ~~PEACETIME~~ STEAM REQUIREMENTS FOR PH-1, continued

AREA LINE OR FACILITY	COMMENTS	PEAK GENERATED POUNDS OF STEAM PER HOUR	Appr'x Month. Peak Steam
Poacher/Blender One House Required	Three tubs on heat build-up 79/3 ~~3~~ x 9,984 x __ hrs	29,952	
	Six tubs on boil cycle 79/6 ~~6~~ x 2,475 x __ hrs	14,850	
NG Area No. 1	Required for DEGDN production, not in referenced production schedule	24,750	-0-
Two Dehy Press Houses	One house each, B-line and C-line 2 x 546 x 24 x 30	1,092	786240
Five Mix Houses	One house B-line, Four houses C-line 5 x 1,012 x (24x30)	5,060	3643200
Four Vertical Press and Cut Houses	4 x 4,211 x (24x30)	16,844 m	12,127,680
Two Horizontal Press and Cut Houses	2 x 3,623 x (24x30)	7,246 m	5217120
Seven Solvent Recovery (SR) Buildings	Five on heat cycle 5 x 1,362* x (24 x 30)	6,810	4903200
	Two on temperature control 2 x 693 x (24 x 30)	1, 386	997,920
Six Water Dry Buildings	Five on heat cycle 5 x 3,348 x (24 x 30)	16,740 m	12052800
	One on temp. control	401	

PEACETIME STEAM REQUIREMENTS FOR PH-1, continued

AREA LINE OR FACILITY	COMMENTS	PEAK GENERATED POUNDS OF STEAM PER HOUR
Four Open Tank Air Dry (AD) Buildings	- Five Tank Buildings -	
	One on heat build-up	8,811 m
	One on temp. control 24 x 15	693
		x 9504 = 3,421,440
	- Two Tank Buildings -	
	Two on heat build-up	
	2 x 3,782	720 x 7,564 = 5,446,080
Two Activated Carbon Recovery Buildings	2 x 13,416	720 x 26,832 m 19319040
One Ether Still House		720 x 11,986 8629920
One Alcohol Rectification Building		29,212 — 0 —
One Caustic Screen House		720 x 655 471,600
All Fourth Rolled Powder Buildings		720 x 38,754 m 27,902,880
First Rolled Powder Line, RAP Finishing Building No. 7113, One Roto-Clone Building No. 6304, One Box Wash, One Sub-Cal LAW Curing Building, and Four First Rolled Powder Houses.		720 x 35,094 m** 25,267,680

PEACETIME STEAM REQUIREMENTS FOR PH-1, continued

AREA LINE OR FACILITY	COMMENTS	PEAK GENERATED POUNDS OF STEAM PER HOUR

Four First Rolled Powder Houses required to meet production schedule for MK90 which increases 31,500 grains per month from referenced production schedule

Three Paste Air Dry Houses	3 x 1,162 x 720	2509920 3,486
CASBL in Standby	Bldg Hrs	5,561 m
Comfort Heat		74,865
Total steam requirements for Powerhouse 1, during peacetime operations		539,393

* - Use of 1,362 lb/hr for solvent recovery buildings is an estimated value. Previously supplied meter reading value of 5,000 lb/hr in referenced letter (87-824-52) dated June 29, 1987 excessively greater than previously metered or estimated values, possibly resulting from an equipment malfunction.

** Use of 35,094 lb/hr is metered value from February 9, 1987 steam balance presented in April 15, 1987 memorandum. Previously supplied meter reading of 90,628 lb/hr from June 29, 1987 letter is excessively greater than previous metered or estimated values, possibly resulting from an equipment malfunction.

m - metered value, adjusted to 0°F

1989

~~PEACETIME~~ STEAM REQUIREMENTS FOR PH-2

Ref: Hercules letter to COR (87-170-108) dated September 10, 1987.

Steam requirements based upon Proposed Production Schedule ~~dated July 17, 1987~~ Jan 1989 for production levels during the winter of ~~1987-88,~~ an ambient temperature of 0 degrees F, 15% Powerhouse 2 internal steam usage and 15% line losses.

AREA LINE OR FACILITY	COMMENTS monthly hrs?	PEAK GENERATED POUNDS OF STEAM PER HOUR
Forced Air Dry Buildings	Five on heat cycle 5 x 6,504 x 720	32,520 m 23,414,400
	Three on temperature control 3 x 4,603 x 720	9942480 13,809 m
NG Area No. 2		16953840 23,547 m
CAMBL		—0— 26,938 m
Six small grain Curing Houses	6 x 2,735* x(24 x 30)	11815,200 16,410 m
Five conditioning buildings	5 x 4,036 x 720	14529,600 20,180

*-Use of metered value of 2,735 lb/hr from June 29, 1987 letter from Hercules to COR (87-824-52). Meter reading value of 5,703 lb/hr used in referenced letter 87-170-108 excessively greater than 2,735 lb/hr meter reading and previous Hercules estimate of 2,630 lb/hr, possibly resulting from an equipment malfunction.

PEACETIME STEAM REQUIREMENTS FOR PH-2, continued

AREA LINE OR FACILITY	COMMENTS	PEAK GENERATED POUNDS OF STEAM PER HOUR
One coning, sleeve insertion, sleeve trimming, inspection and pack-out building, No. 4925		588240 817
Three Solventless Press Houses	3 x 1,661	3522960 4,983
Comfort heat for remaining buildings in Horseshoe Area		12,143
Total Steam requirements for Powerhouse 2, during Peacetime		151,347

m-metered value, adjusted to 0°F

COMFORT HEAT

BIN TEMPS	TOTAL HRS	EST'D #/HR	MBtu/YR
50-54	707	10,000	7,424
45-49	682	15,000	10,742
40-44	702	20,000	14,742
35-39	687	25,000	18,034
30-34	563	30,000	17,735
25-29	292	40,000	12,264
20-24	162	50,000	8,505
15-19	82	60,000	5,166
10-14	25	70,000	1,838
5- 9	9	80,000	756
TOTAL			97,204

$$\text{TOTAL} = \frac{\text{PEAK}}{80{,}000\ \#/\text{HR}} * 97{,}200\ \text{MB}$$

PEAK	MBTU/YR
5,561	6,700
74,865	90,500
20,180	14,500

FUEL OIL CY88	(GAL)	(%)	ASSIGNED AREA
PH#1	240,000	12	UTIL
INCINERATOR	800,000	40	OTHER
PH#2	943,000	47	UTIL
HOUSING	17,000	1	ADM/HEAT
OTHER	2,500	0	OTHER
TOTAL	2,002,500	100	

NATURAL GAS FY89	(CF)	(%)	ASSIGNED AREA
NAC/SAC	9,794,607	24	ACID/NC
IGP	27,180,000	67	SOLVENT
DECON OVENS	3,437,863	9	OTHER
	40,412,470	100	

$3.72 GAL

Consumption of Fuel

Date	SAR	NAC/SAC	Powerhouse #1	Nor Ordnance Staff Village	New River Mag	Nor Ordnance Radford Mag 1993	Nor Ordnance TNT Area	Acid Area 4601-7	Powderline 443-1 443-2	Molecular Sieve	Powderline 432	PH 2 Portable Boilers	Total Fuel Oil
Jan '87	0	0	91338	32781	0	342	0	870	43605	701	0	116875	157009
Feb '87	0	0	24574	2028		407	0		40581	134	0	3672	69805
Mar '87	0	0	18547						40222	600	0	2435	61804
April '87	0	0	15242	2578	0	192	0	550	50794	425	0	14754	84535
May '87	0	0	23037	0	0	0	0	0	42162	1800	0	3976	70995
June '87	0	0	12985	0	0	0	0	0	29389	100	0		43174
July '87	0	0	20392	0	0	0	0	0	24944	0	0	432	45768
Aug '87	0	0	14009	0	0	0	0	0	33103	1700	0		48812
Sept '87	0	0	23714	110	0	0	0	0	68401	868	0	8343	101506
Oct '87	0	0	14954	0	0	157	0	245	90293	1716	0	46149	153574
Nov '87	0	0	14511	2707	0	0	0	0	66924	496	0	90624	175262
Dec '87	0	0	15898	0	0	0	0	0	69303	900	0	60041	146142
Total	0	0	294199	11201	0	941	0	1605	611721	10738	0	242321	1177786
Jan '88	0	0	60532	5176	0	474		689	66411	87		287185	420557
Feb '88	0	0	27743		0				73203			123259	224225
Mar '88	0	0	19088	2890	0	851	0	836	44012	470		92029	184576
April '88	0	0	23041	0	0	0	0	0	76449	0		48605	148102
May '88	0	0	15444	0	0	0	0	0	61657	0	0	80052	157927
June '88	0	0	10901	0	0	0	0	0	53895	0	0	65830	130626
July '88	0	0	12024	0	0	0	0	0	78364	0	0	17293	108283
Aug '88	0	0	13954	0	0	0	0	0	60736	0	0	15126	89816
Sept '88	0	0	11399	270	0	0	0	0	55603	0	0	33421	100673
Oct '88	0	0	19972	3885	0	272	0	950	74421	534	0	92005	194046
Nov 88	0	0	8303	0	0	0	0	0	43988	0	0	79815	132106
Dec 88	0	0	17987	2526	0	0	0	0	83220	0	0	7744	111477
Total	0	0	241839	14747	0	997	0	2475	798968	1091	0	948967	2008484
%			12.0	0.7					40.0			47.1	

$50.70 per 100 GAL

NATURAL GAS USAGE
1989

MONTH CHARGED OUT	NAC/SAC 620-164004 QTY	$	INERT GAS PLANT 745-244000 QTY	$	DECON OVENS 594-204060 QTY	$	SAR 620-164104 QTY	$	TOTAL QTY FT³	TOTAL $
JANUARY	360,527	1,222	2,573,000	8,723	173,573	588	0	0	3,107,100	10,533
FEBRUARY	1,284,444	5,098	1,937,000	7,688	566,856	2,250	0	0	3,788,300	15,036
MARCH	681,357	5,953	2,121,000	18,533	289,443	2,529	0	0	3,091,800	27,015
APRIL	648,595	2,272	2,383,000	8,345	404,105	1,415	0	0	3,435,700	12,032
MAY	532,879	1,883	2,150,000	7,596	175,921	622	0	0	2,858,800	10,101
JUNE *	330,225	0	2,014,000	0	110,075	0	0	0	2,454,300	0
JULY *	136,015	0	926,000	0	111,285	0	0	0	1,173,300	0
AUGUST @	448,056	1,042	1,080,000	2,087	174,244	393	0	0	1,702,300	3,522
SEPTEMBER	543,925	1,893	1,354,000	4,713	213,375	743	0	0	2,111,300	7,349
OCTOBER	261,823	885	2,089,000	7,057	53,477	181	0	0	2,404,300	8,123
NOVEMBER									0	0
DECEMBER									0	0
TOTAL	5,227,846	20,248	18,627,000	64,742	2,272,354	8,721	0	0	26,127,200	93,711
%	20.0		71.3		8.7					

* NO DOLLARS CHARGED DUE TO OVERSTATEMENT OF $15490 IN MARCH.
@ CREDIT ADJUSTMENT OF $2651 DUE TO OVERSTATEMENT IN MARCH.

Thru October

RADFORD ARMY AMMUNITION PLANT
FY 1985-89 PRODUCTION DATA
FILE NAME: DATA8589

MONTH	PH#1 MBTU	PH#2 MBTU	COAL TOT MBTU	ELEC GEN MBTU	ELEC PUR MBTU	TOT ELEC MBTU	NC PROD LBS	AOP LBS	NAC/SAC LBS	NG LBS	HDD
Oct-84	283260	33330	316590	27133	21359	48492	3089744	5312073	8546879	436271	132
Nov-84	306783	56952	363735	25188	19638	44826	2854925	4696735	7900459	439519	680
Dec-84	394263	100041	494304	37877	23150	61028	3875115	5344706	8637984	605425	641
Jan-85	380916	83941	464857	28509	17990	46499	3311986	4363163	8363588	379338	1121
Feb-85	410240	83597	493837	27352	20355	47707	3430135	5371200	8710445	144267	845
Mar-85	437254	99008	536262	33007	24727	57734	3862863	6778329	10127456	0	586
Apr-85	312043	64670	376713	23748	21789	45536	3011494	4273522	7219176	0	312
May-85	274608	47415	322023	21690	22434	44123	3061532	4039199	7373783	0	97
Jun-85	304276	47562	351838	25574	29529	55103	3768219	5400836	10606032	0	31
Jul-85	235132	34068	269200	19529	25659	45188	2585736	5033050	8061918	0	0
Aug-85	279892	44318	324210	22949	32253	55202	3347315	5994096	8691353	0	15
Sep-85	224956	37534	262490	16365	25372	41738	2642476	4183251	6995404	0	101
Oct-85	238279	35420	273698	18208	23795	42004	2666589	4829712	7188631	0	244
Nov-85	362432	64449	426881	24638	26877	51516	3294400	5434380	9214510	0	356
Dec-85	371133	76223	447356	26946	16341	43287	2428622	3538124	5575507	0	983
Jan-86	377991	91929	469920	28662	11754	40417	2371698	3838576	6795980	87869	997
Feb-86	404710	79246	483956	27925	16987	44912	2639278	4728086	6929907	167158	773
Mar-86	430568	92986	523554	32693	19423	52117	3105896	4617368	7557531	183234	650
Apr-86	279720	55649	335370	24130	20355	44485	2171343	2295739	4220611	148704	296
May-86	260032	64916	324948	21055	28167	49222	1549930	3344565	4262647	224913	135
Jun-86	180049	42548	222596	15928	24512	40441	1075013	3500519	3600585	155107	0
Jul-86	195853	38394	234247	15174	25157	40331	1684649	4494215	5610274	169276	1
Aug-86	236460	46923	283383	22621	33615	56236	2510808	3724641	7374045	189136	20
Sep-86	205710	37214	242924	15539	21789	37328	1602221	1664775	4733546	87861	53
Oct-86	215984	42302	258287	19109	16270	35379	1849585	2718971	4180717	124797	345
Nov-86	381580	71823	453403	25185	20498	45683	1866578	2784873	5270456	194445	595
Dec-86	281711	73175	354886	23884	16628	40512	1842285	1171941	3689246	217152	897
Jan-87	408864	102646	511510	29188	15911	45099	2563214	3361257	5766875	227585	1027
Feb-87	365972	87972	453943	26877	13976	40854	2483119	2434790	5106834	178408	806
Mar-87	320843	78238	399081	24539	14621	39161	2314053	2651569	4714036	275331	666
Apr-87	302088	73937	376025	23000	18563	41564	3102295	3497919	6501074	244518	450
May-87	298377	74182	372559	21898	28956	50854	3794927	3742102	9647327	364196	90
Jun-87	211216	44932	256148	15997	25516	41512	2914324	3574194	6396072	256875	15
Jul-87	206865	45473	252338	16068	24942	41011	3034934	1859272	6822250	197917	4
Aug-87	254723	55379	310101	19809	32611	52420	3940281	5227243	10055102	384967	7
Sep-87	189020	45842	234862	16952	24512	41465	2617012	3769549	6949571	272632	75

RADFORD ARMY AMMUNITION PLANT
FY 1985-89 PRODUCTION DATA
FILE NAME: DATA8589

MONTH	PH#1 MBTU	PH#2 MBTU	COAL TOT MBTU	ELEC GEN MBTU	ELEC PUR MBTU	TOT ELEC MBTU	NC PROD LBS	AOP LBS	NAC/SAC LBS	NG LBS	HDD
Oct-87	347242	74232	421473	28833	26161	54994	3265020	4717950	11678597	376823	547
Nov-87	283579	63564	347143	23584	19208	42792	2624519	2759250	4909316	250071	594
Dec-87	392813	91561	484373	26301	18492	44792	2863991	3229258	5954979	285035	839
Jan-88	464341	80868	545209	34260	21287	55547	3529253	3779441	7335130	333804	1220
Feb-88	307668	76640	384308	25611	18133	43744	3073848	2822051	6093826	376424	943
Mar-88	398983	71970	470953	23840	22792	46632	3422157	4964739	11088583	253766	673
Apr-88	362309	82835	445144	25601	26161	51762	3734380	4375497	9499569	269594	452
May-88	245136	47906	293043	19304	22577	41881	2761406	2904756	5556980	292462	211
Jun-88	206325	33994	240319	16604	23007	39611	2578299	2627555	6234479	158275	101
Jul-88	263227	49086	312313	19765	34475	54239	3298155	3478576	9983961	234032	10
Aug-88	220753	38615	259368	17208	30318	47526	3097861	3108895	9569329	304725	11
Sep-88	211019	40213	251232	16099	24512	40611	2812986	3203245	7305359	363272	135
Oct-88	353706	74428	428134	27127	22219	49345	3907912	4145719	11330094	446377	518
Nov-88	252879	30725	283604	22307	14335	36642	2084293	3506661	5697900	298957	597
Dec-88	477245	94436	571682	33253	16771	50024	3344439	3795318	6545238	464398	900
Jan-89	352674	75584	428257	25925	13188	39113	2719628	2523300	6692200	327700	828
Feb-89	320474	74527	395001	24591	13188	37778	1626232	2643400	4229800	195400	837
Mar-89	250151	70692	320843	0	27522	27522	1750724	730100	2172200	183100	659
Apr-89	286603	66735	353338	14079	31536	45615	3085460	3664300	6186100	230100	452
May-89	171372	44711	216083	20475	32038	52512	2501288	3335600	5233100	366300	290
Jun-89	94707	34142	128848	5986	21000	26987	987067	1312200	2573300	161000	10
Jul-89	91339	38836	130176	0	26806	26806	1530282	1970200	2734800	291600	0
Aug-89	135608	31118	166726	0	36482	36482	2305368	2321700	4711900	306500	31
Sep-89	174444	41811	216255	0	43577	43577	2033241	3261600	7044700	432900	119
TOTALS	17488400	3683460	21171860	1295701	1391818	2687519	163202403	218775851	409759251	13559516	25023

Radford Army Ammunition Plant
List of Buildings Surveyed

11/06/90
01:51 PM

Count	Bldg. No.	Name/Process	Location	Similar
1	266 -03	Refrigeration Equipment House	Ballistics Range	1
2	400 -00	Power House #1	Power	1
3	407 -00	Filter Plant & Pump Station	Plant Water	1
4	408 -00	River Pump House	Plant Water	1
5	409 -00	Filter Plant	Plant Water	1
6	419 -00	Drinking Water Plant	Plant Water	1
7	420 -02	Acid Waste Disposal (C-Line)	Waste Acid	1
8	421 -00	Inert Gas Producer & Burn Hse.	Inert Gas	1
9	424 -00	Sewage Disposal Plant	Waste Water	1
10	440 -00	Incinerator 6A	Incinerator	1
11	441 -00	Incinerator 6B	Incinerator	1
12	442 -00	Grind House	Incinerator	1
13	470 -00	Biological Treatment Building	Waste Water	1
14	700 -00	Air Compressor House	Acid	1
15	702 -00	Oxidation House	Acid	1
16	735 -02	NAC/SAC Plant	Acid	1
17	736 -00	NAC/SAC Cooling Tower	Acid	1
18	1000 -00	Cotton Linter Warehouse	NC, A&B-Line	1
19	1505 -00	Change House	Green, A-Line	3
20	1606 -00	Open Tank Air Dry	Sol. Recovery, A-Line	10
21	1611 -00	Solvent Recovery House	Sol. Recovery, B-Line	27
22	1674 -00	Water Dry House	Sol. Recovery, C-Line	32
23	1800 -00	Glaze House	Finish, A-Line	3
24	1827 -00	Final Blend House	Finish	4
25	1877 -00	Can Pack house	Finish	3
26	2000 -00	Cotton Linter Warehouse	NC, A&B-Line	2
27	2010 -00	Dry House and Conveyer	NC, B-Line	3
28	2019 -00	Boiling Tub House	NC, B-Line	3
29	2022 -00	Beater House	NC, B-Line	3
30	2024 -00	Poacher & Blending House	NC, B-Line	3
31	2026 -00	Final Wringer House	Green, B-Line	3
32	2046 -00	Control House	NC, B-Line	2
33	2050 -00	Molecular Sieve Building	NC, B-Line	2
34	2500 -00	Dehy Press House	Green, B-Line	3
35	2506 -00	Diphenylamine Mix House	Green, B-Line	3
36	2508 -00	Mix House	Green, B-Line	6
37	2510 -00	Pre. & Horizontal Press House	Green, B-Line	9
38	2516 -00	Finishing Press & Cut House	Green, B-Line	4
39	2521 -00	Hydraulic Pump House	Green, B-Line	3
40	2555 -00	Activated Carbon Vapor Recov.	Green, B-Line	3
41	3513 -00	C-1 Press & Cutting House	Green, C-Line	3
42	3523 -00	Cooling Tower	Green, C-Line	2
43	3647 -00	Premix House Number 1	NG #1	2
44	3805 -00	Glycerin/Soda/Refrig. House	NG #1	1
45	4329 -00	Power House #2	Cast Prop. (Rocket)	1

46	4903 -00	Inert Gas Producer & Burn Hse.	Inert Gas	1
47	4906 -00	Final Mix House	Green, C-Line	1
48	4908 -00	Press and Cutting House	Green, C-Line	3
49	4912 -03	MK 43 Sawing and Inhibiting	Cast Prop. (Rocket)	1
50	4912 -03	Vacuum & Air Conditioning Hse.	Cast Prop. (Rocket)	4
51	4912 -04	SG Evacuation and Casting	Cast Prop. (Rocket)	1
52	4912 -07	Pin Assembly *	Cast Prop. (Rocket)	1
53	4912 -11	LG Mold Loading House	Cast Prop. (Rocket)	2
54	4912 -15	Spiral Wrap House	Cast Prop. (Rocket)	1
55	4912 -27	SG Curing Hse.- Carpet Rolls	Cast Prop. (Rocket)	10
56	4912 -34	Forced Air Dry House	Pilot B	2
57	4912 -40	Forced Air Dry House	Pilot B	19
58	4915 -00	Small Grain Mold Assembly	Cast Prop. (Rocket)	1
59	4921 -00	Inspect/Clean NG Tanks *	Cast Prop. (Rocket)	1
60	4924 -01	LG Motor Load House	Cast Prop. (Rocket)	1
61	4924 -05	MK 43 Dowel Rod & Spiral Wrap	Cast Prop. (Rocket)	1
62	4924 -06	Machine and Saw House	Cast Prop. (Rocket)	1
63	4925 -00	MK 43 Finishing Operations	Pilot B	1
64	4951 -02	TOW Launch Saw House	Pilot B	1
65	5008 -01	15 Inch Press House	Pilot A	3
66	5010 -00	Igniter Assemble & Inspect	Igniter Line	1
67	6304 -00	Paste Blending House	1st R P	1
68	7104 -00	Diff. & Even Speed Roll House	1st R P	5
69	7106 -06	Dry House #6 (Dry Packing)	1st R P	7
70	7113 -00	Roll House (Rolled Powder)	1st R P (F-Line)	1
71	7113 -00	Cut, Mill, Bore & Trim	Grain Finish	1
72	7127 -00	Carpet Roll and Slitter House	1st R P	1
73	7801 -00	Extruded Grain Finishing	Grain Finish	2
74	9304 -00	Slurry Mix House	Premix 2	2
75	9309 -03	Rolled Powder Building	4th Rolled Powder	1
76	9309 -04	Rolled Powder Building	4th Rolled Powder	1
77	9310 -02	Rolled Powder Building	4th Rolled Powder	2
78	9334 -15	Blender House	4th Rolled Powder	1
79	9334 -17	Rest House	4th Rolled Powder	8
80	9354 -00	Compressor House	4th Rolled Powder	1
81	9465 -00	Glycerin/Soda/Sol/Refrig Hse.	NG #2	1
82	9467 -00	Generator House	NG #2	1
83	9488 -00	Compressor House	NG #2	1

Number Of Buildings Represented By The 83 Buildings Surveyed: 255

PRELIMINARY EVALUATION OF ECOs

Some ECOs are not practical, have been previously accomplished, or can be eliminated from detailed analysis based on preliminary analysis. The following pages represent the results of the preliminary evaluation of all ECOs for each building surveyed. If an ECO has been previously accomplished, causes a safety hazard, or does not apply to that building (i.e., a thermal energy storage project for a building with no air conditioning system) then it is considered "Not Applicable." Based on previous experience and engineering judgement the potential savings for some projects are very low compared to the probable installation cost. These projects are considered to have "Low Potential Savings" and were eliminated from further detailed analysis.

PRELIMINARY EVALUATION OF ECO'S

AREA: GP BUILDING NAME: Power House # 1 NUMBER: 0400-00

	ECO Description	Project Status
A.	Production equipment changes	Not Applicable
B.	Efficient motors & var. speed drive	Not Applicable
C.	Production equipment scheduling	Not Applicable
D.	Waste heat recovery	Not Applicable
E.	Automated production controls	Not Applicable
F.	Improve facility layout	Not Applicable
G.	Solar applications	Not Applicable
H.	Consolidate process	Not Applicable
I.	Building ventilation systems	Not Applicable
J.	Production equipment maintenance	ECO Analysis Performed
K.	Improved methods/controls	Not Applicable
L.	Steam/condensate distribution	Not Applicable
M.	Compressed air systems	Not Applicable
N.	Lighting systems	Not Applicable
O.	Electrical distribution	Not Applicable
P.	Radiant heating	Not Applicable
Q.	Loading dock seals	Not Applicable
R.	Thermal energy storage	Not Applicable
S.	Flue gas recirculation	Not Applicable
T.	Ventilation instead of A/C	Not Applicable
U.	Insulation	Not Applicable
V.	Reduction of glass area	Not Applicable
W.	Cargo door strip curtains	Not Applicable
X.	Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECOS

AREA: __________ BUILDING NAME: Filter Plant & Pump Station NUMBER: 407

ECO Description	Project Status
A. Production equipment changes	NA
B. Efficient motors & var. speed drive	LPS
C. Production equipment scheduling	NA
D. Waste heat recovery	NA
E. Automated production controls	NA
F. Improve facility layout	LPS
G. Solar applications	NA
H. Consolidate process	NA
I. Building ventilation systems	LPS
J. Production equipment maintenance	LPS
K. Improved methods/controls	LPS
L. Steam/condensate distribution	LPS
M. Compressed air systems	NA
N. Lighting systems	LPS
O. Electrical distribution	LPS
P. Radiant heating	LPS
Q. Loading dock seals	NA
R. Thermal energy storage	NA
S. Flue gas recirculation	NA
T. Ventilation instead of A/C	NA
U. Insulation	LPS
V. Reduction of glass area	LPS
W. Cargo door strip curtains	NA
X. Other applicable ECOs	LPS

PRELIMINARY EVALUATION OF ECOS

AREA: Plant Water BUILDING NAME: River Pump House NUMBER: 408

ECO Description	Project Status
A. Production equipment changes	NA
B. Efficient motors & var. speed drive	ECO
C. Production equipment scheduling	NA
D. Waste heat recovery	NA
E. Automated production controls	NA
F. Improve facility layout	NA
G. Solar applications	NA
H. Consolidate process	NA
I. Building ventilation systems	NA
J. Production equipment maintenance	NA
K. Improved methods/controls	ECO
L. Steam/condensate distribution	NA
M. Compressed air systems	NA
N. Lighting systems	LPS
O. Electrical distribution	LPS
P. Radiant heating	LPS
Q. Loading dock seals	NA
R. Thermal energy storage	NA
S. Flue gas recirculation	NA
T. Ventilation instead of A/C	NA
U. Insulation	LPS
V. Reduction of glass area	LPS
W. Cargo door strip curtains	NA
X. Other applicable ECOs	LPS

PRELIMINARY EVALUATION OF ECOS

AREA: Plant Water BUILDING NAME: Filter Plant NUMBER: 409

ECO Description	Project Status
A. Production equipment changes	NA
B. Efficient motors & var. speed drive	ECO
C. Production equipment scheduling	NA
D. Waste heat recovery	NA
E. Automated production controls	NA
F. Improve facility layout	NA
G. Solar applications	NA
H. Consolidate process	NA
I. Building ventilation systems	NA
J. Production equipment maintenance	LPS
K. Improved methods/controls	LPS
L. Steam/condensate distribution	NA
M. Compressed air systems	NA
N. Lighting systems	LPS
O. Electrical distribution	LPS
P. Radiant heating	LPS
Q. Loading dock seals	NA
R. Thermal energy storage	NA
S. Flue gas recirculation	NA
T. Ventilation instead of A/C	NA
U. Insulation	LPS
V. Reduction of glass area	LPS
W. Cargo door strip curtains	NA
X. Other applicable ECOs	LPS

PRELIMINARY EVALUATION OF ECOS

AREA: Plant Water BUILDING NAME: Drinking Water Plant NUMBER: 419

ECO Description	Project Status
A. Production equipment changes	NA
B. Efficient motors & var. speed drive	ECO
C. Production equipment scheduling	NA
D. Waste heat recovery	NA
E. Automated production controls	LPS
F. Improve facility layout	NA
G. Solar applications	NA
H. Consolidate process	NA
I. Building ventilation systems	LPS
J. Production equipment maintenance	LPS
K. Improved methods/controls	LPS
L. Steam/condensate distribution	LPS
M. Compressed air systems	NA
N. Lighting systems	LPS
O. Electrical distribution	LPS
P. Radiant heating	LPS
Q. Loading dock seals	NA
R. Thermal energy storage	NA
S. Flue gas recirculation	NA
T. Ventilation instead of A/C	NA
U. Insulation	LPS
V. Reduction of glass area	LPS
W. Cargo door strip curtains	NA
X. Other applicable ECOs	LPS

PRELIMINARY EVALUATION OF ECOS

AREA: Waste Acid BUILDING NAME: Acid Waste Disposal NUMBER: 420-02

ECO Description	Project Status
A. Production equipment changes	NA
B. Efficient motors & var. speed drive	ECO
C. Production equipment scheduling	NA
D. Waste heat recovery	NA
E. Automated production controls	NA
F. Improve facility layout	NA
G. Solar applications	NA
H. Consolidate process	NA
I. Building ventilation systems	NA
J. Production equipment maintenance	LPS
K. Improved methods/controls	LPS
L. Steam/condensate distribution	LPS
M. Compressed air systems	NA
N. Lighting systems	LPS
O. Electrical distribution	LPS
P. Radiant heating	LPS
Q. Loading dock seals	NA
R. Thermal energy storage	NA
S. Flue gas recirculation	NA
T. Ventilation instead of A/C	NA
U. Insulation	LPS
V. Reduction of glass area	LPS
W. Cargo door strip curtains	NA
X. Other applicable ECOs	LPS

PRELIMINARY EVALUATION OF ECO'S

AREA: GP BUILDING NAME: Inert Gas Prod. NUMBER: 0421-00

	ECO Description	Project Status
A.	Production equipment changes	Not Applicable
B.	Efficient motors & var. speed drive	Not Applicable
C.	Production equipment scheduling	Not Applicable
D.	Waste heat recovery	ECO Analysis Performed
E.	Automated production controls	Not Applicable
F.	Improve facility layout	Not Applicable
G.	Solar applications	Not Applicable
H.	Consolidate processes	Not Applicable
I.	Building ventilation systems	Not Applicable
J.	Production equipment maintenance	Not Applicable
K.	Improved methods/controls	Not Applicable
L.	Steam/condensate distribution	Not Applicable
M.	Compressed air systems	Not Applicable
N.	Lighting systems	Not Applicable
O.	Electrical distribution	Not Applicable
P.	Radiant heating	Not Applicable
Q.	Loading dock seals	Not Applicable
R.	Thermal energy storage	Not Applicable
S.	Flue gas recirculation	Not Applicable
T.	Ventilation instead of A/C	Not Applicable
U.	Insulation	Not Applicable
V.	Reduction of glass area	Not Applicable
W.	Cargo door strip curtains	Not Applicable
X.	Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECOS

AREA: Waste Water BUILDING NAME: Sewage Disposal Plant NUMBER: 424

ECO Description	Project Status
A. Production equipment changes	NA
B. Efficient motors & var. speed drive	ECO
C. Production equipment scheduling	NA
D. Waste heat recovery	NA
E. Automated production controls	NA
F. Improve facility layout	NA
G. Solar applications	NA
H. Consolidate process	NA
I. Building ventilation systems	LPS
J. Production equipment maintenance	LPS
K. Improved methods/controls	LPS
L. Steam/condensate distribution	LPS
M. Compressed air systems	NA
N. Lighting systems	LPS
O. Electrical distribution	LPS
P. Radiant heating	LPS
Q. Loading dock seals	NA
R. Thermal energy storage	NA
S. Flue gas recirculation	NA
T. Ventilation instead of A/C	NA
U. Insulation	LPS
V. Reduction of glass area	LPS
W. Cargo door strip curtains	NA
X. Other applicable ECOs	LPS

PRELIMINARY EVALUATION OF ECO'S

AREA: GP   BUILDING NAME: Incinerator   NUMBER: 0440-00

ECO Description		Project Status
A.	Production equipment changes	ECO Analysis Performed
B.	Efficient motors & var. speed drive	Not Applicable
C.	Production equipment scheduling	Not Applicable
D.	Waste heat recovery	Not Applicable
E.	Automated production controls	Not Applicable
F.	Improve facility layout	Not Applicable
G.	Solar applications	Not Applicable
H.	Consolidate processes	Not Applicable
I.	Building ventilation systems	Not Applicable
J.	Production equipment maintenance	Not Applicable
K.	Improved methods/controls	ECO Analysis Performed
L.	Steam/condensate distribution	Not Applicable
M.	Compressed air systems	Not Applicable
N.	Lighting systems	Not Applicable
O.	Electrical distribution	Not Applicable
P.	Radiant heating	Not Applicable
Q.	Loading dock seals	Not Applicable
R.	Thermal energy storage	Not Applicable
S.	Flue gas recirculation	Not Applicable
T.	Ventilation instead of A/C	Not Applicable
U.	Insulation	Not Applicable
V.	Reduction of glass area	Not Applicable
W.	Cargo door strip curtains	Not Applicable
X.	Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: GP   BUILDING NAME: Grind House   NUMBER: 442-00

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Not Applicable
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Not Applicable
G. Solar applications	Not Applicable
H. Consolidate processes	Low Potential Savings
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	ECO Analysis Performed
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Not Applicable
N. Lighting systems	Low Potential Savings
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Low Potential Savings
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Low Potential Savings
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECOS

AREA: Waste Water BUILDING NAME: Biological Treatment Bldg. NUMBER: 470

ECO Description	Project Status
A. Production equipment changes	NA
B. Efficient motors & var. speed drive	ECO
C. Production equipment scheduling	NA
D. Waste heat recovery	NA
E. Automated production controls	NA
F. Improve facility layout	NA
G. Solar applications	NA
H. Consolidate process	NA
I. Building ventilation systems	LPS
J. Production equipment maintenance	LPS
K. Improved methods/controls	LPS
L. Steam/condensate distribution	LPS
M. Compressed air systems	NA
N. Lighting systems	LPS
O. Electrical distribution	LPS
P. Radiant heating	LPS
Q. Loading dock seals	NA
R. Thermal energy storage	NA
S. Flue gas recirculation	NA
T. Ventilation instead of A/C	NA
U. Insulation	LPS
V. Reduction of glass area	LPS
W. Cargo door strip curtains	NA
X. Other applicable ECOs	LPS

PRELIMINARY EVALUATION OF ECOS

AREA: Plant Air BUILDING NAME: Compressor Bldg. NUMBER: 700

ECO Description	Project Status
A. Production equipment changes	LPS
B. Efficient motors & var. speed drive	LPS
C. Production equipment scheduling	NA
D. Waste heat recovery	LPS
E. Automated production controls	NA
F. Improve facility layout	NA
G. Solar applications	NA
H. Consolidate process	NA
I. Building ventilation systems	NA
J. Production equipment maintenance	NA
K. Improved methods/controls	NA
L. Steam/condensate distribution	NA
M. Compressed air systems	LPS
N. Lighting systems	LPS
O. Electrical distribution	LPS
P. Radiant heating	LPS
Q. Loading dock seals	NA
R. Thermal energy storage	NA
S. Flue gas recirculation	NA
T. Ventilation instead of A/C	NA
U. Insulation	LPS
V. Reduction of glass area	LPS
W. Cargo door strip curtains	NA
X. Other applicable ECOs	LPS

PRELIMINARY EVALUATION OF ECOS

AREA: Acid BUILDING NAME: Oxidation House NUMBER: 702

ECO Description	Project Status
A. Production equipment changes	LPS
B. Efficient motors & var. speed drive	ECO
C. Production equipment scheduling	LPS
D. Waste heat recovery	EXISTS
E. Automated production controls	EXISTS
F. Improve facility layout	LPS
G. Solar applications	NA
H. Consolidate process	NA
I. Building ventilation systems	LPS
J. Production equipment maintenance	LPS
K. Improved methods/controls	LPS
L. Steam/condensate distribution	LPS
M. Compressed air systems	NA
N. Lighting systems	LPS
O. Electrical distribution	LPS
P. Radiant heating	LPS
Q. Loading dock seals	NA
R. Thermal energy storage	NA
S. Flue gas recirculation	NA
T. Ventilation instead of A/C	NA
U. Insulation	LPS
V. Reduction of glass area	LPS
W. Cargo door strip curtains	NA
X. Other applicable ECOs	LPS

PRELIMINARY EVALUATION OF ECO'S

AREA: NC BUILDING NAME: Cotton Warehouse NUMBER: 1000-00

ECO Description	Project Status
A. Production equipment changes	Not Applicable
B. Efficient motors & var. speed drive	Not Applicable
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Not Applicable
E. Automated production controls	Not Applicable
F. Improve facility layout	Not Applicable
G. Solar applications	Low Potential Savings
H. Consolidate process	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Low Potential Savings
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Low Potential Savings
V. Reduction of glass area	Not Applicable
W. Cargo door strip curtains	Low Potential Savings
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECOS

AREA: Green A-Line BUILDING NAME: Change House NUMBER: 1505

ECO Description	Project Status
A. Production equipment changes	NA
B. Efficient motors & var. speed drive	NA
C. Production equipment scheduling	NA
D. Waste heat recovery	NA
E. Automated production controls	NA
F. Improve facility layout	NA
G. Solar applications	NA
H. Consolidate process	NA
I. Building ventilation systems	NA
J. Production equipment maintenance	NA
K. Improved methods/controls	NA
L. Steam/condensate distribution	NA
M. Compressed air systems	NA
N. Lighting systems	LPS
O. Electrical distribution	LPS
P. Radiant heating	LPS
Q. Loading dock seals	NA
R. Thermal energy storage	NA
S. Flue gas recirculation	NA
T. Ventilation instead of A/C	NA
U. Insulation	LPS
V. Reduction of glass area	LPS
W. Cargo door strip curtains	NA
X. Other applicable ECOs	LPS

PRELIMINARY EVALUATION OF ECO'S

AREA: FN BUILDING NAME: Open Tank Air Dry NUMBER: 1606-00

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	ECO Analysis Performed
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Low Potential Savings
G. Solar applications	Low Potential Savings
H. Consolidate process	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Not Applicable
L. Steam/condensate distribution	Review Previous EEAP
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Low Potential Savings
V. Reduction of glass area	Not Applicable
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	ECO Analysis Performed

PRELIMINARY EVALUATION OF ECO'S

AREA: SR BUILDING NAME: Solvent Recovery NUMBER: 1611-00

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Not Applicable
F. Improve facility layout	Not Applicable
G. Solar applications	Low Potential Savings
H. Consolidate process	Not Applicable
I. Building ventilation systems	Not Applicable
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Review Previous EEAP
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Low/No Cost Project
V. Reduction of glass area	Not Applicable
W. Cargo door strip curtains	ECO Analysis Performed
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: FN BUILDING NAME: Water Dry NUMBER: 1674-00

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Not Applicable
G. Solar applications	Low Potential Savings
H. Consolidate process	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Review Previous EEAP
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	ECO Analysis Performed
V. Reduction of glass area	Not Applicable
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	ECO Analysis Performed

PRELIMINARY EVALUATION OF ECO'S

AREA: FN BUILDING NAME: Glaze House NUMBER: 1800-00

ECO Description	Project Status
A. Production equipment changes	Not Applicable
B. Efficient motors & var. speed drive	Not Applicable
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Not Applicable
E. Automated production controls	Not Applicable
F. Improve facility layout	Not Applicable
G. Solar applications	Not Applicable
H. Consolidate processes	Not Applicable
I. Building ventilation systems	Not Applicable
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Not Applicable
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Not Applicable
N. Lighting systems	Not Applicable
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Not Applicable
V. Reduction of glass area	Not Applicable
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: FN BUILDING NAME: Final Blend NUMBER: 1827-00

	ECO Description	Project Status
A.	Production equipment changes	Not Applicable
B.	Efficient motors & var. speed drive	Not Applicable
C.	Production equipment scheduling	Not Applicable
D.	Waste heat recovery	Not Applicable
E.	Automated production controls	Not Applicable
F.	Improve facility layout	Not Applicable
G.	Solar applications	Not Applicable
H.	Consolidate processes	Not Applicable
I.	Building ventilation systems	Not Applicable
J.	Production equipment maintenance	Not Applicable
K.	Improved methods/controls	Not Applicable
L.	Steam/condensate distribution	Not Applicable
M.	Compressed air systems	Not Applicable
N.	Lighting systems	Not Applicable
O.	Electrical distribution	Not Applicable
P.	Radiant heating	Not Applicable
Q.	Loading dock seals	Not Applicable
R.	Thermal energy storage	Not Applicable
S.	Flue gas recirculation	Not Applicable
T.	Ventilation instead of A/C	Not Applicable
U.	Insulation	Not Applicable
V.	Reduction of glass area	Not Applicable
W.	Cargo door strip curtains	Not Applicable
X.	Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: FN BUILDING NAME: Can Pack NUMBER: 1877-00

ECO Description	Project Status
A. Production equipment changes	Not Applicable
B. Efficient motors & var. speed drive	Not Applicable
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Not Applicable
E. Automated production controls	Not Applicable
F. Improve facility layout	Not Applicable
G. Solar applications	Not Applicable
H. Consolidate processes	Not Applicable
I. Building ventilation systems	Not Applicable
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Not Applicable
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Not Applicable
N. Lighting systems	Not Applicable
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Not Applicable
V. Reduction of glass area	Not Applicable
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: NC   BUILDING NAME: Cotton Warehouse   NUMBER: 2000-00

ECO Description	Project Status
A. Production equipment changes	Not Applicable
B. Efficient motors & var. speed drive	Not Applicable
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Not Applicable
E. Automated production controls	Not Applicable
F. Improve facility layout	Not Applicable
G. Solar applications	Low Potential Savings
H. Consolidate process	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Not Applicable
N. Lighting systems	Low Potential Savings
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Low Potential Savings
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Low Potential Savings
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Low Potential Savings
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: NC BUILDING NAME: Dry House & Conv. NUMBER: 2010-00

ECO Description		Project Status
A.	Production equipment changes	Low Potential Savings
B.	Efficient motors & var. speed drive	ECO Analysis Performed
C.	Production equipment scheduling	Not Applicable
D.	Waste heat recovery	Low Potential Savings
E.	Automated production controls	Low Potential Savings
F.	Improve facility layout	Not Applicable
G.	Solar applications	Low Potential Savings
H.	Consolidate process	Low Potential Savings
I.	Building ventilation systems	Low Potential Savings
J.	Production equipment maintenance	Not Applicable
K.	Improved methods/controls	Low Potential Savings
L.	Steam/condensate distribution	Review Previous EEAP
M.	Compressed air systems	Low Potential Savings
N.	Lighting systems	ECO Analysis Performed
O.	Electrical distribution	Not Applicable
P.	Radiant heating	Not Applicable
Q.	Loading dock seals	Low Potential Savings
R.	Thermal energy storage	Not Applicable
S.	Flue gas recirculation	Not Applicable
T.	Ventilation instead of A/C	Not Applicable
U.	Insulation	Not Applicable
V.	Reduction of glass area	Low Potential Savings
W.	Cargo door strip curtains	ECO Analysis Performed
X.	Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: NC   BUILDING NAME: Boiling Tub House   NUMBER: 2019-00

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Low/No Cost Project
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Not Applicable
G. Solar applications	Low Potential Savings
H. Consolidate process	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Review Previous EEAP
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	ECO Analysis Performed
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	ECO Analysis Performed

PRELIMINARY EVALUATION OF ECO'S

AREA: NC BUILDING NAME: Jordan Beaters NUMBER: 2022-00

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Not Applicable
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Not Applicable
G. Solar applications	Not Applicable
H. Consolidate process	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low/No Cost Project
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Low Potential Savings
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Low Potential Savings
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: NC   BUILDING NAME: Poacher & Blend.   NUMBER: 2024-00

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	ECO Analysis Performed
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Not Applicable
G. Solar applications	Low Potential Savings
H. Consolidate process	Low Potential Savings
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Not Applicable
L. Steam/condensate distribution	Review Previous EEAP
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	ECO Analysis Performed
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: NC   BUILDING NAME: Final Wringer   NUMBER: 2026-00

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Not Applicable
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Not Applicable
G. Solar applications	Not Applicable
H. Consolidate process	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Review Previous EEAP
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Not Applicable
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	ECO Analysis Performed
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: NC BUILDING NAME: Dehy Press House NUMBER: 2500-00

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Not Applicable
E. Automated production controls	Not Applicable
F. Improve facility layout	Not Applicable
G. Solar applications	Not Applicable
H. Consolidate process	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Review Previous EEAP
M. Compressed air systems	Not Applicable
N. Lighting systems	Not Applicable
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Not Applicable
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: NC BUILDING NAME: Dip. Mix House NUMBER: 2506-00

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Not Applicable
G. Solar applications	Not Applicable
H. Consolidate processes	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Low Potential Savings
M. Compressed air systems	Not Applicable
N. Lighting systems	Low Potential Savings
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Low Potential Savings
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Not Applicable
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: NC BUILDING NAME: Mix House NUMBER: 2508-00

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Not Applicable
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Low Potential Savings
G. Solar applications	Not Applicable
H. Consolidate process	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Not Applicable
N. Lighting systems	Low Potential Savings
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Low Potential Savings
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Not Applicable
V. Reduction of glass area	Not Applicable
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: NC BUILDING NAME: Block House NUMBER: 2510-00

	ECO Description	Project Status
A.	Production equipment changes	Low Potential Savings
B.	Efficient motors & var. speed drive	ECO Analysis Performed
C.	Production equipment scheduling	Not Applicable
D.	Waste heat recovery	Not Applicable
E.	Automated production controls	Low Potential Savings
F.	Improve facility layout	Not Applicable
G.	Solar applications	Not Applicable
H.	Consolidate process	Low Potential Savings
I.	Building ventilation systems	Not Applicable
J.	Production equipment maintenance	Not Applicable
K.	Improved methods/controls	Not Applicable
L.	Steam/condensate distribution	Review Previous EEAP
M.	Compressed air systems	Not Applicable
N.	Lighting systems	Low Potential Savings
O.	Electrical distribution	Not Applicable
P.	Radiant heating	Not Applicable
Q.	Loading dock seals	Not Applicable
R.	Thermal energy storage	Not Applicable
S.	Flue gas recirculation	Not Applicable
T.	Ventilation instead of A/C	Not Applicable
U.	Insulation	Not Applicable
V.	Reduction of glass area	Low Potential Savings
W.	Cargo door strip curtains	Low Potential Savings
X.	Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECOS

AREA: Green B-Line   BUILDING NAME: Finishing Press & Cut House   NUMBER: 2516

ECO Description	Project Status
A. Production equipment changes	LPS
B. Efficient motors & var. speed drive	LPS
C. Production equipment scheduling	LPS
D. Waste heat recovery	LPS
E. Automated production controls	LPS
F. Improve facility layout	LPS
G. Solar applications	NA
H. Consolidate process	NA
I. Building ventilation systems	LPS
J. Production equipment maintenance	LPS
K. Improved methods/controls	LPS
L. Steam/condensate distribution	LPS
M. Compressed air systems	NA
N. Lighting systems	LPS
O. Electrical distribution	LPS
P. Radiant heating	LPS
Q. Loading dock seals	NA
R. Thermal energy storage	NA
S. Flue gas recirculation	NA
T. Ventilation instead of A/C	NA
U. Insulation	LPS
V. Reduction of glass area	LPS
W. Cargo door strip curtains	NA
X. Other applicable ECOs	LPS

PRELIMINARY EVALUATION OF ECO'S

AREA: NC BUILDING NAME: Hydr. Pump House NUMBER: 2521-00

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	Not Applicable
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Not Applicable
F. Improve facility layout	Not Applicable
G. Solar applications	Not Applicable
H. Consolidate processes	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Review Previous EEAP
M. Compressed air systems	Not Applicable
N. Lighting systems	Low Potential Savings
O. Electrical distribution	Low Potential Savings
P. Radiant heating	Low Potential Savings
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Low Potential Savings
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Low/No Cost Project

PRELIMINARY EVALUATION OF ECO'S

AREA: NC BUILDING NAME: A.C. Vapor Recov. NUMBER: 2555-00

	ECO Description	Project Status
A.	Production equipment changes	Not Applicable
B.	Efficient motors & var. speed drive	ECO Analysis Performed
C.	Production equipment scheduling	Not Applicable
D.	Waste heat recovery	Low Potential Savings
E.	Automated production controls	Not Applicable
F.	Improve facility layout	Not Applicable
G.	Solar applications	Not Applicable
H.	Consolidate process	Not Applicable
I.	Building ventilation systems	ECO Analysis Performed
J.	Production equipment maintenance	Not Applicable
K.	Improved methods/controls	Low Potential Savings
L.	Steam/condensate distribution	Review Previous EEAP
M.	Compressed air systems	Not Applicable
N.	Lighting systems	Low Potential Savings
O.	Electrical distribution	Not Applicable
P.	Radiant heating	Not Applicable
Q.	Loading dock seals	Not Applicable
R.	Thermal energy storage	Not Applicable
S.	Flue gas recirculation	Not Applicable
T.	Ventilation instead of A/C	Not Applicable
U.	Insulation	Low Potential Savings
V.	Reduction of glass area	Low Potential Savings
W.	Cargo door strip curtains	Not Applicable
X.	Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECOS

AREA: C-Line BUILDING NAME: Cutting and Press NUMBER: 3513

ECO Description	Project Status
A. Production equipment changes	LPS
B. Efficient motors & var. speed drive	ECO
C. Production equipment scheduling	LPS
D. Waste heat recovery	LPS
E. Automated production controls	LPS
F. Improve facility layout	LPS
G. Solar applications	NA
H. Consolidate process	NA
I. Building ventilation systems	LPS
J. Production equipment maintenance	LPS
K. Improved methods/controls	LPS
L. Steam/condensate distribution	LPS
M. Compressed air systems	NA
N. Lighting systems	ECO
O. Electrical distribution	LPS
P. Radiant heating	LPS
Q. Loading dock seals	NA
R. Thermal energy storage	NA
S. Flue gas recirculation	NA
T. Ventilation instead of A/C	NA
U. Insulation	LPS
V. Reduction of glass area	LPS
W. Cargo door strip curtains	ECO
X. Other applicable ECOs	LPS

PRELIMINARY EVALUATION OF ECOS

AREA: N6 BUILDING NAME: Premix House NUMBER: 3647

ECO Description	Project Status
A. Production equipment changes	LPS
B. Efficient motors & var. speed drive	ECO
C. Production equipment scheduling	LPS
D. Waste heat recovery	LPS
E. Automated production controls	LPS
F. Improve facility layout	LPS
G. Solar applications	NA
H. Consolidate process	LPS
I. Building ventilation systems	LPS
J. Production equipment maintenance	LPS
K. Improved methods/controls	LPS
L. Steam/condensate distribution	LPS
M. Compressed air systems	NA
N. Lighting systems	ECO
O. Electrical distribution	LPS
P. Radiant heating	LPS
Q. Loading dock seals	NA
R. Thermal energy storage	NA
S. Flue gas recirculation	NA
T. Ventilation instead of A/C	NA
U. Insulation	LPS
V. Reduction of glass area	LPS
W. Cargo door strip curtains	NA
X. Other applicable ECOs	LPS

PRELIMINARY EVALUATION OF ECO'S

AREA: GP BUILDING NAME: Power House # 2 NUMBER: 4329-00

ECO Description	Project Status
A. Production equipment changes	Not Applicable
B. Efficient motors & var. speed drive	Not Applicable
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Not Applicable
E. Automated production controls	Not Applicable
F. Improve facility layout	Not Applicable
G. Solar applications	Not Applicable
H. Consolidate processes	Not Applicable
I. Building ventilation systems	Not Applicable
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low/No Cost Project
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Not Applicable
N. Lighting systems	Not Applicable
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Not Applicable
V. Reduction of glass area	Not Applicable
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: GP BUILDING NAME: Inert Gas House NUMBER: 4903-00

	ECO Description	Project Status
A.	Production equipment changes	Not Applicable
B.	Efficient motors & var. speed drive	Not Applicable
C.	Production equipment scheduling	Not Applicable
D.	Waste heat recovery	Not Applicable
E.	Automated production controls	Not Applicable
F.	Improve facility layout	Not Applicable
G.	Solar applications	Not Applicable
H.	Consolidate processes	Not Applicable
I.	Building ventilation systems	Not Applicable
J.	Production equipment maintenance	Not Applicable
K.	Improved methods/controls	Not Applicable
L.	Steam/condensate distribution	Not Applicable
M.	Compressed air systems	Not Applicable
N.	Lighting systems	Not Applicable
O.	Electrical distribution	Not Applicable
P.	Radiant heating	Not Applicable
Q.	Loading dock seals	Not Applicable
R.	Thermal energy storage	Not Applicable
S.	Flue gas recirculation	Not Applicable
T.	Ventilation instead of A/C	Not Applicable
U.	Insulation	Not Applicable
V.	Reduction of glass area	Not Applicable
W.	Cargo door strip curtains	Not Applicable
X.	Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: NC BUILDING NAME: Final Mix House NUMBER: 4906-00

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Not Applicable
G. Solar applications	Low Potential Savings
H. Consolidate process	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Low Potential Savings
M. Compressed air systems	Not Applicable
N. Lighting systems	Low Potential Savings
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Low Potential Savings
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Not Applicable
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: NC BUILDING NAME: Press & Cutting NUMBER: 4908-00

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Low Potential Savings
G. Solar applications	Low Potential Savings
H. Consolidate process	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Low Potential Savings
M. Compressed air systems	Not Applicable
N. Lighting systems	Low Potential Savings
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Low/No Cost Project
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RK BUILDING NAME: Saw & Inhibiting NUMBER: 4912-03

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Not Applicable
G. Solar applications	Low Potential Savings
H. Consolidate processes	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Low Potential Savings
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Low Potential Savings
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Low Potential Savings
U. Insulation	Low/No Cost Project
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RK   BUILDING NAME: Saw & Inhibiting   NUMBER: 4912-04

ECO Description		Project Status
A.	Production equipment changes	Low Potential Savings
B.	Efficient motors & var. speed drive	ECO Analysis Performed
C.	Production equipment scheduling	Low Potential Savings
D.	Waste heat recovery	Low Potential Savings
E.	Automated production controls	Low Potential Savings
F.	Improve facility layout	Not Applicable
G.	Solar applications	Low Potential Savings
H.	Consolidate processes	Not Applicable
I.	Building ventilation systems	Low Potential Savings
J.	Production equipment maintenance	Not Applicable
K.	Improved methods/controls	Low Potential Savings
L.	Steam/condensate distribution	Not Applicable
M.	Compressed air systems	Low Potential Savings
N.	Lighting systems	ECO Analysis Performed
O.	Electrical distribution	Not Applicable
P.	Radiant heating	Not Applicable
Q.	Loading dock seals	Not Applicable
R.	Thermal energy storage	Low Potential Savings
S.	Flue gas recirculation	Not Applicable
T.	Ventilation instead of A/C	Low Potential Savings
U.	Insulation	Not Applicable
V.	Reduction of glass area	Low Potential Savings
W.	Cargo door strip curtains	Not Applicable
X.	Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RK   BUILDING NAME: Pin Assembly   NUMBER: 4912-07

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Low Potential Savings
G. Solar applications	Low Potential Savings
H. Consolidate process	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Low/No Cost Project
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Low Potential Savings
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	ECO Analysis Performed
U. Insulation	Low/No Cost Project
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RK BUILDING NAME: Mold Loading NUMBER: 4912-11

	ECO Description	Project Status
A.	Production equipment changes	Low Potential Savings
B.	Efficient motors & var. speed drive	ECO Analysis Performed
C.	Production equipment scheduling	Low Potential Savings
D.	Waste heat recovery	Low Potential Savings
E.	Automated production controls	Low Potential Savings
F.	Improve facility layout	Not Applicable
G.	Solar applications	Low Potential Savings
H.	Consolidate processes	Not Applicable
I.	Building ventilation systems	Low/No Cost Project
J.	Production equipment maintenance	Not Applicable
K.	Improved methods/controls	Not Applicable
L.	Steam/condensate distribution	Not Applicable
M.	Compressed air systems	Not Applicable
N.	Lighting systems	ECO Analysis Performed
O.	Electrical distribution	Not Applicable
P.	Radiant heating	Not Applicable
Q.	Loading dock seals	Not Applicable
R.	Thermal energy storage	Low Potential Savings
S.	Flue gas recirculation	Not Applicable
T.	Ventilation instead of A/C	Low Potential Savings
U.	Insulation	Low/No Cost Project
V.	Reduction of glass area	Low Potential Savings
W.	Cargo door strip curtains	Not Applicable
X.	Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RK BUILDING NAME: Spiral Wrap NUMBER: 4912-15

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Low Potential Savings
G. Solar applications	Low Potential Savings
H. Consolidate process	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Low Potential Savings
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Low Potential Savings
U. Insulation	Not Applicable
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RK BUILDING NAME: Curing House NUMBER: 4912-27

	ECO Description	Project Status
A.	Production equipment changes	Low Potential Savings
B.	Efficient motors & var. speed drive	ECO Analysis Performed
C.	Production equipment scheduling	Low Potential Savings
D.	Waste heat recovery	Not Applicable
E.	Automated production controls	Low Potential Savings
F.	Improve facility layout	Not Applicable
G.	Solar applications	Low Potential Savings
H.	Consolidate processes	Low Potential Savings
I.	Building ventilation systems	Low Potential Savings
J.	Production equipment maintenance	Not Applicable
K.	Improved methods/controls	Not Applicable
L.	Steam/condensate distribution	Not Applicable
M.	Compressed air systems	Not Applicable
N.	Lighting systems	ECO Analysis Performed
O.	Electrical distribution	Not Applicable
P.	Radiant heating	Not Applicable
Q.	Loading dock seals	Not Applicable
R.	Thermal energy storage	Not Applicable
S.	Flue gas recirculation	Not Applicable
T.	Ventilation instead of A/C	Not Applicable
U.	Insulation	Not Applicable
V.	Reduction of glass area	Low Potential Savings
W.	Cargo door strip curtains	Not Applicable
X.	Other applicable ECO's	ECO Analysis Performed

PRELIMINARY EVALUATION OF ECO'S

AREA: MF BUILDING NAME: Forced Air Dry NUMBER: 4912-34

ECO Description	Project Status
A. Production equipment changes	Not Applicable
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Not Applicable
E. Automated production controls	Not Applicable
F. Improve facility layout	Not Applicable
G. Solar applications	Low Potential Savings
H. Consolidate process	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Not Applicable
V. Reduction of glass area	Not Applicable
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	ECO Analysis Performed

PRELIMINARY EVALUATION OF ECO'S

AREA: MF BUILDING NAME: Forced Air Dry NUMBER: 4912-40

ECO Description	Project Status
A. Production equipment changes	Not Applicable
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Not Applicable
E. Automated production controls	Not Applicable
F. Improve facility layout	Not Applicable
G. Solar applications	Low Potential Savings
H. Consolidate processes	Not Applicable
I. Building ventilation systems	Review Previous EEAP
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Low/No Cost Project
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Low/No Cost Project
V. Reduction of glass area	Not Applicable
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	ECO Analysis Performed

PRELIMINARY EVALUATION OF ECO'S

AREA: RK BUILDING NAME: Mold Assembly NUMBER: 4915-00

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Not Applicable
E. Automated production controls	Not Applicable
F. Improve facility layout	Low Potential Savings
G. Solar applications	Low Potential Savings
H. Consolidate processes	Low Potential Savings
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Not Applicable
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Low/No Cost Project
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Low Potential Savings
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RK   BUILDING NAME: Dessicator Insp.   NUMBER: 4921-00

ECO Description	Project Status
A. Production equipment changes	Not Applicable
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Not Applicable
E. Automated production controls	Not Applicable
F. Improve facility layout	Low Potential Savings
G. Solar applications	Low Potential Savings
H. Consolidate processes	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Not Applicable
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Low Potential Savings
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RK   BUILDING NAME: Motor Load House   NUMBER: 4924-01

ECO Description	Project Status
A. Production equipment changes	Not Applicable
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Not Applicable
F. Improve facility layout	Low Potential Savings
G. Solar applications	Low Potential Savings
H. Consolidate processes	Not Applicable
I. Building ventilation systems	Low/No Cost Project
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Not Applicable
L. Steam/condensate distribution	Low/No Cost Project
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Low Potential Savings
R. Thermal energy storage	Low Potential Savings
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Low Potential Savings
U. Insulation	Low Potential Savings
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Low Potential Savings
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RK BUILDING NAME: Dowel Rod NUMBER: 4924-05

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Not Applicable
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Not Applicable
G. Solar applications	Not Applicable
H. Consolidate process	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Not Applicable
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Low Potential Savings
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Low Potential Savings
U. Insulation	Not Applicable
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RK BUILDING NAME: Machine & Sawing NUMBER: 4924-06

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Low Potential Savings
G. Solar applications	Low Potential Savings
H. Consolidate process	Low Potential Savings
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Low/No Cost Project
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Low Potential Savings
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Low Potential Savings
U. Insulation	Not Applicable
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RK BUILDING NAME: Finishing Oper. NUMBER: 4925-00

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Not Applicable
F. Improve facility layout	Low Potential Savings
G. Solar applications	Low Potential Savings
H. Consolidate processes	Low Potential Savings
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Low Potential Savings
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Low Potential Savings
U. Insulation	Low Potential Savings
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RK BUILDING NAME: TOW Saw House NUMBER: 4951-02

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Not Applicable
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Low Potential Savings
G. Solar applications	Low Potential Savings
H. Consolidate processes	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Not Applicable
L. Steam/condensate distribution	Review Previous EEAP
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Not Applicable
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RK   BUILDING NAME: 15" Press House   NUMBER: 5008-01

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Not Applicable
G. Solar applications	Low Potential Savings
H. Consolidate processes	Not Applicable
I. Building ventilation systems	Low/No Cost Project
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Low/No Cost Project
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Low/No Cost Project
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RK BUILDING NAME: Igniter Assembly NUMBER: 5010-00

ECO Description	Project Status
A. Production equipment changes	Not Applicable
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Not Applicable
F. Improve facility layout	Low Potential Savings
G. Solar applications	Low Potential Savings
H. Consolidate processes	Low Potential Savings
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Low Potential Savings
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Low Potential Savings
U. Insulation	Not Applicable
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECOS

AREA: 1st R.P. BUILDING NAME: Paste Blending House NUMBER: 6304

ECO Description	Project Status
A. Production equipment changes	LPS
B. Efficient motors & var. speed drive	ECO
C. Production equipment scheduling	LPS
D. Waste heat recovery	LPS
E. Automated production controls	LPS
F. Improve facility layout	LPS
G. Solar applications	LPS
H. Consolidate process	LPS
I. Building ventilation systems	LPS
J. Production equipment maintenance	LPS
K. Improved methods/controls	LPS
L. Steam/condensate distribution	LPS
M. Compressed air systems	NA
N. Lighting systems	ECO
O. Electrical distribution	LPS
P. Radiant heating	LPS
Q. Loading dock seals	NA
R. Thermal energy storage	NA
S. Flue gas recirculation	NA
T. Ventilation instead of A/C	NA
U. Insulation	LPS
V. Reduction of glass area	LPS
W. Cargo door strip curtains	NA
X. Other applicable ECOs	LPS

PRELIMINARY EVALUATION OF ECOS

AREA: 1st R.P. BUILDING NAME: Differential & Even Speed Roll House NUMBER: 7104

ECO Description	Project Status
A. Production equipment changes	LPS
B. Efficient motors & var. speed drive	ECO
C. Production equipment scheduling	LPS
D. Waste heat recovery	LPS
E. Automated production controls	LPS
F. Improve facility layout	LPS
G. Solar applications	LPS
H. Consolidate process	LPS
I. Building ventilation systems	LPS
J. Production equipment maintenance	LPS
K. Improved methods/controls	LPS
L. Steam/condensate distribution	LPS
M. Compressed air systems	NA
N. Lighting systems	ECO
O. Electrical distribution	LPS
P. Radiant heating	LPS
Q. Loading dock seals	NA
R. Thermal energy storage	NA
S. Flue gas recirculation	NA
T. Ventilation instead of A/C	NA
U. Insulation	LPS
V. Reduction of glass area	LPS
W. Cargo door strip curtains	NA
X. Other applicable ECOs	LPS

PRELIMINARY EVALUATION OF ECO'S

AREA: RP   BUILDING NAME: Dry House No. 6   NUMBER: 7106-06

ECO Description	Project Status
A. Production equipment changes	Not Applicable
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Not Applicable
D. Waste heat recovery	ECO Analysis Performed
E. Automated production controls	Not Applicable
F. Improve facility layout	Not Applicable
G. Solar applications	Low Potential Savings
H. Consolidate process	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	ECO Analysis Performed
L. Steam/condensate distribution	Low/No Cost Project
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Low/No Cost Project
V. Reduction of glass area	Not Applicable
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	ECO Analysis Performed

PRELIMINARY EVALUATION OF ECO'S

AREA: RK BUILDING NAME: Roll House NUMBER: 7113-RK

ECO Description	Project Status
A. Production equipment changes	ECO Analysis Performed
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Low Potential Savings
G. Solar applications	Low Potential Savings
H. Consolidate processes	Low Potential Savings
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Not Applicable
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Low Potential Savings
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Low Potential Savings
U. Insulation	Not Applicable
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RP BUILDING NAME: Roll House NUMBER: 7113-RP

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Low Potential Savings
G. Solar applications	Low Potential Savings
H. Consolidate processes	Low Potential Savings
I. Building ventilation systems	Low/No Cost Project
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low Potential Savings
L. Steam/condensate distribution	Low/No Cost Project
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Not Applicable
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	ECO Analysis Performed
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECOS

AREA: 1st R.P. BUILDING NAME: Carpet Roll & Slitter House NUMBER: 7127

ECO Description	Project Status
A. Production equipment changes	LPS
B. Efficient motors & var. speed drive	ECO
C. Production equipment scheduling	LPS
D. Waste heat recovery	LPS
E. Automated production controls	LPS
F. Improve facility layout	LPS
G. Solar applications	LPS
H. Consolidate process	LPS
I. Building ventilation systems	LPS
J. Production equipment maintenance	LPS
K. Improved methods/controls	LPS
L. Steam/condensate distribution	LPS
M. Compressed air systems	NA
N. Lighting systems	ECO
O. Electrical distribution	LPS
P. Radiant heating	LPS
Q. Loading dock seals	NA
R. Thermal energy storage	NA
S. Flue gas recirculation	NA
T. Ventilation instead of A/C	NA
U. Insulation	LPS
V. Reduction of glass area	LPS
W. Cargo door strip curtains	NA
X. Other applicable ECOs	LPS

PRELIMINARY EVALUATION OF ECO'S

AREA: RK BUILDING NAME: Ex. Grain Finish NUMBER: 7801-00

	ECO Description	Project Status
A.	Production equipment changes	Low Potential Savings
B.	Efficient motors & var. speed drive	ECO Analysis Performed
C.	Production equipment scheduling	Low Potential Savings
D.	Waste heat recovery	Not Applicable
E.	Automated production controls	Low Potential Savings
F.	Improve facility layout	Low/No Cost Project
G.	Solar applications	Not Applicable
H.	Consolidate processes	Not Applicable
I.	Building ventilation systems	Low Potential Savings
J.	Production equipment maintenance	Not Applicable
K.	Improved methods/controls	Not Applicable
L.	Steam/condensate distribution	Review Previous EEAP
M.	Compressed air systems	Not Applicable
N.	Lighting systems	ECO Analysis Performed
O.	Electrical distribution	Not Applicable
P.	Radiant heating	Not Applicable
Q.	Loading dock seals	Not Applicable
R.	Thermal energy storage	Low Potential Savings
S.	Flue gas recirculation	Not Applicable
T.	Ventilation instead of A/C	Not Applicable
U.	Insulation	Low Potential Savings
V.	Reduction of glass area	Not Applicable
W.	Cargo door strip curtains	Not Applicable
X.	Other applicable ECO's	Low/No Cost Project

PRELIMINARY EVALUATION OF ECO'S

AREA: NG BUILDING NAME: Slurry Mix NUMBER: 9304-00

	ECO Description	Project Status
A.	Production equipment changes	ECO Analysis Performed
B.	Efficient motors & var. speed drive	Not Applicable
C.	Production equipment scheduling	Not Applicable
D.	Waste heat recovery	Not Applicable
E.	Automated production controls	Not Applicable
F.	Improve facility layout	Not Applicable
G.	Solar applications	Not Applicable
H.	Consolidate processes	Not Applicable
I.	Building ventilation systems	Not Applicable
J.	Production equipment maintenance	Not Applicable
K.	Improved methods/controls	Not Applicable
L.	Steam/condensate distribution	Not Applicable
M.	Compressed air systems	Not Applicable
N.	Lighting systems	Not Applicable
O.	Electrical distribution	Not Applicable
P.	Radiant heating	Not Applicable
Q.	Loading dock seals	Not Applicable
R.	Thermal energy storage	Not Applicable
S.	Flue gas recirculation	Not Applicable
T.	Ventilation instead of A/C	Not Applicable
U.	Insulation	Low Potential Savings
V.	Reduction of glass area	Not Applicable
W.	Cargo door strip curtains	Not Applicable
X.	Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RP BUILDING NAME: Rolled Powder NUMBER: 9309-03

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	ECO Analysis Performed
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Low Potential Savings
G. Solar applications	Low Potential Savings
H. Consolidate process	Low Potential Savings
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Low/No Cost Project
L. Steam/condensate distribution	Review Previous EEAP
M. Compressed air systems	Low Potential Savings
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Low Potential Savings
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Low/No Cost Project
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Low Potential Savings
X. Other applicable ECO's	Low/No Cost Project

PRELIMINARY EVALUATION OF ECO'S

AREA: RP BUILDING NAME: Rolled Powder NUMBER: 9309-04

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Low Potential Savings
G. Solar applications	Low Potential Savings
H. Consolidate processes	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Not Applicable
L. Steam/condensate distribution	Low/No Cost Project
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Low Potential Savings
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Low Potential Savings
U. Insulation	Not Applicable
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RP BUILDING NAME: Rolled Powder NUMBER: 9310-02

ECO Description		Project Status
A.	Production equipment changes	Low Potential Savings
B.	Efficient motors & var. speed drive	ECO Analysis Performed
C.	Production equipment scheduling	Low Potential Savings
D.	Waste heat recovery	Not Applicable
E.	Automated production controls	Low Potential Savings
F.	Improve facility layout	Low Potential Savings
G.	Solar applications	Low Potential Savings
H.	Consolidate processes	Not Applicable
I.	Building ventilation systems	Low/No Cost Project
J.	Production equipment maintenance	Not Applicable
K.	Improved methods/controls	Not Applicable
L.	Steam/condensate distribution	Review Previous EEAP
M.	Compressed air systems	Not Applicable
N.	Lighting systems	ECO Analysis Performed
O.	Electrical distribution	Not Applicable
P.	Radiant heating	Not Applicable
Q.	Loading dock seals	Not Applicable
R.	Thermal energy storage	Low Potential Savings
S.	Flue gas recirculation	Not Applicable
T.	Ventilation instead of A/C	Low Potential Savings
U.	Insulation	Not Applicable
V.	Reduction of glass area	Low Potential Savings
W.	Cargo door strip curtains	Not Applicable
X.	Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RP BUILDING NAME: Blender House NUMBER: 9334-15

ECO Description	Project Status
A. Production equipment changes	Low Potential Savings
B. Efficient motors & var. speed drive	ECO Analysis Performed
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Not Applicable
E. Automated production controls	Low Potential Savings
F. Improve facility layout	Low Potential Savings
G. Solar applications	Low Potential Savings
H. Consolidate process	Not Applicable
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Not Applicable
L. Steam/condensate distribution	Review Previous EEAP
M. Compressed air systems	Not Applicable
N. Lighting systems	ECO Analysis Performed
O. Electrical distribution	Not Applicable
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Not Applicable
V. Reduction of glass area	Low Potential Savings
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RP BUILDING NAME: Rest House NUMBER: 9334-17

	ECO Description	Project Status
A.	Production equipment changes	Not Applicable
B.	Efficient motors & var. speed drive	Low Potential Savings
C.	Production equipment scheduling	Not Applicable
D.	Waste heat recovery	Not Applicable
E.	Automated production controls	Not Applicable
F.	Improve facility layout	Not Applicable
G.	Solar applications	Low Potential Savings
H.	Consolidate processes	Not Applicable
I.	Building ventilation systems	Low Potential Savings
J.	Production equipment maintenance	Not Applicable
K.	Improved methods/controls	Not Applicable
L.	Steam/condensate distribution	Review Previous EEAP
M.	Compressed air systems	Not Applicable
N.	Lighting systems	ECO Analysis Performed
O.	Electrical distribution	Not Applicable
P.	Radiant heating	Not Applicable
Q.	Loading dock seals	Not Applicable
R.	Thermal energy storage	Not Applicable
S.	Flue gas recirculation	Not Applicable
T.	Ventilation instead of A/C	Not Applicable
U.	Insulation	Not Applicable
V.	Reduction of glass area	Low Potential Savings
W.	Cargo door strip curtains	Not Applicable
X.	Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: RP   BUILDING NAME: Compressor House   NUMBER: 9354-00

	ECO Description	Project Status
A.	Production equipment changes	Not Applicable
B.	Efficient motors & var. speed drive	ECO Analysis Performed
C.	Production equipment scheduling	Low Potential Savings
D.	Waste heat recovery	Low Potential Savings
E.	Automated production controls	Not Applicable
F.	Improve facility layout	Not Applicable
G.	Solar applications	Not Applicable
H.	Consolidate processes	Low Potential Savings
I.	Building ventilation systems	Low Potential Savings
J.	Production equipment maintenance	Not Applicable
K.	Improved methods/controls	Low/No Cost Project
L.	Steam/condensate distribution	Not Applicable
M.	Compressed air systems	Low Potential Savings
N.	Lighting systems	Low Potential Savings
O.	Electrical distribution	Low Potential Savings
P.	Radiant heating	Not Applicable
Q.	Loading dock seals	Not Applicable
R.	Thermal energy storage	Not Applicable
S.	Flue gas recirculation	Not Applicable
T.	Ventilation instead of A/C	Not Applicable
U.	Insulation	Not Applicable
V.	Reduction of glass area	Not Applicable
W.	Cargo door strip curtains	Not Applicable
X.	Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: NG   BUILDING NAME: Generator House   NUMBER: 9467-00

ECO Description	Project Status
A. Production equipment changes	Not Applicable
B. Efficient motors & var. speed drive	Not Applicable
C. Production equipment scheduling	Low Potential Savings
D. Waste heat recovery	Low Potential Savings
E. Automated production controls	Not Applicable
F. Improve facility layout	Not Applicable
G. Solar applications	Not Applicable
H. Consolidate processes	Low Potential Savings
I. Building ventilation systems	Low Potential Savings
J. Production equipment maintenance	Not Applicable
K. Improved methods/controls	Not Applicable
L. Steam/condensate distribution	Not Applicable
M. Compressed air systems	Low Potential Savings
N. Lighting systems	Low Potential Savings
O. Electrical distribution	Low Potential Savings
P. Radiant heating	Not Applicable
Q. Loading dock seals	Not Applicable
R. Thermal energy storage	Not Applicable
S. Flue gas recirculation	Not Applicable
T. Ventilation instead of A/C	Not Applicable
U. Insulation	Not Applicable
V. Reduction of glass area	Not Applicable
W. Cargo door strip curtains	Not Applicable
X. Other applicable ECO's	Not Applicable

PRELIMINARY EVALUATION OF ECO'S

AREA: NG   BUILDING NAME: Compressor House   NUMBER: 9488-00

	ECO Description	Project Status
A.	Production equipment changes	Low Potential Savings
B.	Efficient motors & var. speed drive	Not Applicable
C.	Production equipment scheduling	Low Potential Savings
D.	Waste heat recovery	Low Potential Savings
E.	Automated production controls	Not Applicable
F.	Improve facility layout	Not Applicable
G.	Solar applications	Low Potential Savings
H.	Consolidate processes	Low Potential Savings
I.	Building ventilation systems	Low Potential Savings
J.	Production equipment maintenance	Not Applicable
K.	Improved methods/controls	Not Applicable
L.	Steam/condensate distribution	Not Applicable
M.	Compressed air systems	Low Potential Savings
N.	Lighting systems	Low Potential Savings
O.	Electrical distribution	Low Potential Savings
P.	Radiant heating	Not Applicable
Q.	Loading dock seals	Not Applicable
R.	Thermal energy storage	Not Applicable
S.	Flue gas recirculation	Not Applicable
T.	Ventilation instead of A/C	Not Applicable
U.	Insulation	Not Applicable
V.	Reduction of glass area	Not Applicable
W.	Cargo door strip curtains	Not Applicable
X.	Other applicable ECO's	Not Applicable

ECO# FN-U-1

COVER WATER DRY TANK SURFACE WITH SPHERES

Assumptions:

1. Heat losses due to radiation from the tank are neglected due to the low temperature difference and being indoors.

2. Heat losses due to convection from the tank are neglected due to the still air conditions in the building.

3. The average room conditions are 70 °F db, 60 % RH, 56°F dew point.

4. The tank temperature is 149 °F. Waterland & Viar, Industrial Steam System Analysis for RAAP.

5. The tank diameter is 16 feet. RAAP building inventory printout.

6. The evaporation rate is given by the following equation:
$$\dot{m}_{evap}\left(\frac{lb}{hr}\right) = \frac{A\,(95 + 0.425\,v)}{Y}\,(p_w - p_a)$$

ASHRAE HVAC Systems Handbook, 1987, page 20.8.

Calculations:

$$\text{Area of surface} = \pi r^2 = \pi \times (8\ ft)^2 = 201\ ft^2$$

$$Q_{conduction} = UA\Delta T$$

$$Q_{Evaporation} = \dot{m}\,(C_{vap} + C_p * \Delta T)$$

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SUBJECT Cover Water Dry Tank
DESIGNER W. T. Todd
CHECKER
AEP NO.
SHEET 2 OF
DATE
DATE

Plastic Spheres (Continued):

$U_{Top} = 1/R_{Air} = 1/0.68 = 1.47$ Btu/hr·ft²·°F

$\Delta T = 149°F - 70°F = 79°F$

$Y = h_{fg}$ = heat of vaporization @ 149°F = 1008.3 Btu/lb — ASHRAE FUND. Table 4, p. 6.15

$C_p = 1$ Btu/lb·°F

V = air velocity = 1 ft/min

p_w = Sat. Vapor Press. @ 149°F $\approx p_s = 7.394$ in. Hg. — ASHRAE Fund. Table 2, p. 6.8

p_a = Sat. Vapor Press. @ 56°F (d.pt.) = 0.452 in. Hg. — ASHRAE Fund. Table 2, p. 6.6

$$\dot{m}_{evap} = \frac{201\,(95 + 0.425 \times 1)}{1008}(7.394 - 0.452) = (\text{lb/hr})$$

$\dot{m}_{evap} = 132$ lb/hr

$$\text{FY 89 WD cycles} = \frac{181 \text{ FY88 WD cycles}}{12 \times 10^6 \text{ \#NC}} \times 25 \times 10^6 \text{ \#NC} = 377$$

$$377 \text{ WD Cycles} \div 15 \text{ Active bldgs} \div 2 \text{ tanks/bldg} = 12.6 \frac{\text{cycles}}{\text{tank}}$$

FY 88 cycles/tank = 181 WD cycles ÷ 8 bldgs ÷ 2 tanks ea = 11.3

Use ~ 12 WD cycles/tank per year

$$\text{Average cycle time} = \frac{65000 \text{ hours}}{181 \text{ cycles}} \times \frac{1 \text{ day}}{24 \text{ hrs}} = 15 \frac{\text{days}}{\text{cycle}} = 360 \frac{\text{hrs}}{\text{cycle}}$$

12 cyc/yr × 360 hr/cycle = 4320 hours/yr

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SUBJECT Cover Water Dry Tank
AEP NO.
SHEET 3 OF
DESIGNER W. T. Todd
DATE
CHECKER JH
DATE

Plastic Spheres (Continued):

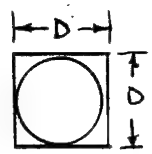
$$Q_{cond} = 1.47 \frac{Btu}{hr \cdot ft^2 \, ^\circ F} \times 201 ft^2 \times 79^\circ F \times 4320 \frac{hrs}{yr} = \underline{100.8 \ MBtu/yr}$$

$$Q_{Evap} = 132 \frac{lb}{hr} \times 4320 \frac{hr}{yr} \times \left[1008.3 \frac{Btu}{lb} + 1 \frac{Btu}{lb \, ^\circ F} \times (149-53)^\circ F\right]$$

$$Q_{Evap} = 570{,}240 \frac{lb}{yr} \times \left(1008.3 \frac{Btu}{lb} + 96 \frac{Btu}{lb}\right) = \underline{629.7 \ MBtu/yr}$$

Exposed Surface Area Reduction By Addition of Plastic Spheres:

minimum:



$$\frac{\text{area of circle}}{\text{area of square}} = \frac{\pi D^2/4}{D \times D} = \pi/4 = 0.785$$

Maximum = 0.884 (see attached calculations)

Use 0.85

Assume 2" plastic spheres with a 1.5" air space

Neglect R-Value of plastic

Minimum $R_{Air\ Space} = 0.77 \frac{ft^2, hr, ^\circ F}{Btu}$ 1981 ASHRAE Fund. Page 23.13, Table 2

$$U_{spheres} = 1/R_T = \frac{1}{R_{air} + R_{Film}} = \frac{1}{.77 + .68} = 0.69 \ Btu/Hr \cdot ft^2 \cdot {}^\circ F$$

$$U_{surface} = 0.85 \times 0.69 \frac{Btu}{hr \cdot ft^2 \, ^\circ F} + 0.15 \times 1.47 \frac{Btu}{hr \cdot ft^2 \, ^\circ F} = 0.81 \ Btu/hr \cdot ft^2 \cdot {}^\circ F$$

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SUBJECT Cover Water Dry Tank
DESIGNER W. T. Todd
CHECKER
AEP NO
SHEET 4 OF
DATE
DATE

Plastic Spheres (Continued): (FN-U-1)

$$Q_{cond\text{-}new} = UA\Delta T = 0.51 \frac{Btu}{hr\text{-}Ft^2\,^\circ F} \times 201 Ft^2 \times 79^\circ F \times 4320 \text{ hr/yr}$$

$$= 55.6 \text{ MBtu/yr}$$

$$Q_{Evap\text{-}new} = Q_{Evap} \times (1-0.85) = 629.7 \frac{MBtu}{hr} \times 0.15$$

$$= 94.5 \text{ MBtu/yr}$$

Steam Savings:

$$Savings = (Q_{old} - Q_{new}) * \text{No. Tanks}$$

$$= \left[(100.8 + 629.7)\frac{MBtu}{Yr} - (55.6 + 94.5)\frac{MBtu}{Yr}\right] * 2 \frac{Tanks}{bldg} * 8 \text{ bldg}$$

$$Savings = 9286.4 \text{ MBtu/yr}$$

Coal Savings:

Savings = Steam Savings * steam savings factor

$$Energy = 9286.4 \frac{MBtu}{Yr} * 1.32 = \underline{12{,}258 \frac{MBtu}{Yr}}$$

$$Cost = 12{,}258 \frac{MBtu}{Yr} \times 1.61 \text{ \$/mbtu} = \underline{\$19{,}735 \text{ /yr}}$$

Elec. Price Diff. Costs:

$$\$1.11 * 9286.4 = \underline{\$10{,}308} \text{ / yr}$$

FN-U-1

Cost Savings:

Cost Savings = COAL $ saving - EL PRICE DIFF COSTS
= \$19,735 - 10,308 = \$9427 yr.

Construction Cost:

Project Cost = \$49,899 See Construction Cost Estimate Sheet.

2" polypropylene or HDPE hollow spheres

$500 \frac{\text{balls}}{\text{case}} \times \frac{\pi D^2}{4} \times \frac{1\,ft^2}{144\,in^2} = 500 \times \frac{\pi}{144}\ ft^2/case = 10.9\ ft^2/case$

$10.9\ ft^2/case \div 0.85\ (\%\ cover) = 12.8\ ft^2$ coverage per case

$201\ ft^2 \div 12.8\ ft^2/case = 15.7 \Rightarrow 16$ cases/tank

Simple Payback

Payback = Cost ÷ Savings
= \$49,899 ÷ \$9427 = 5.3 years

CONSTRUCTION COST ESTIMATE	DATE PREPARED June 4, 1990	SHEET 6 OF

PROJECT ENERGY ENGINEERING ANALYSIS	BASIS FOR ESTIMATE
LOCATION RADFORD ARMY AMMUNITION PLANT	☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design)
ARCHITECT ENGINEER REYNOLDS, SMITH AND HILLS A.E.P., INC.	☐ OTHER (Specify)

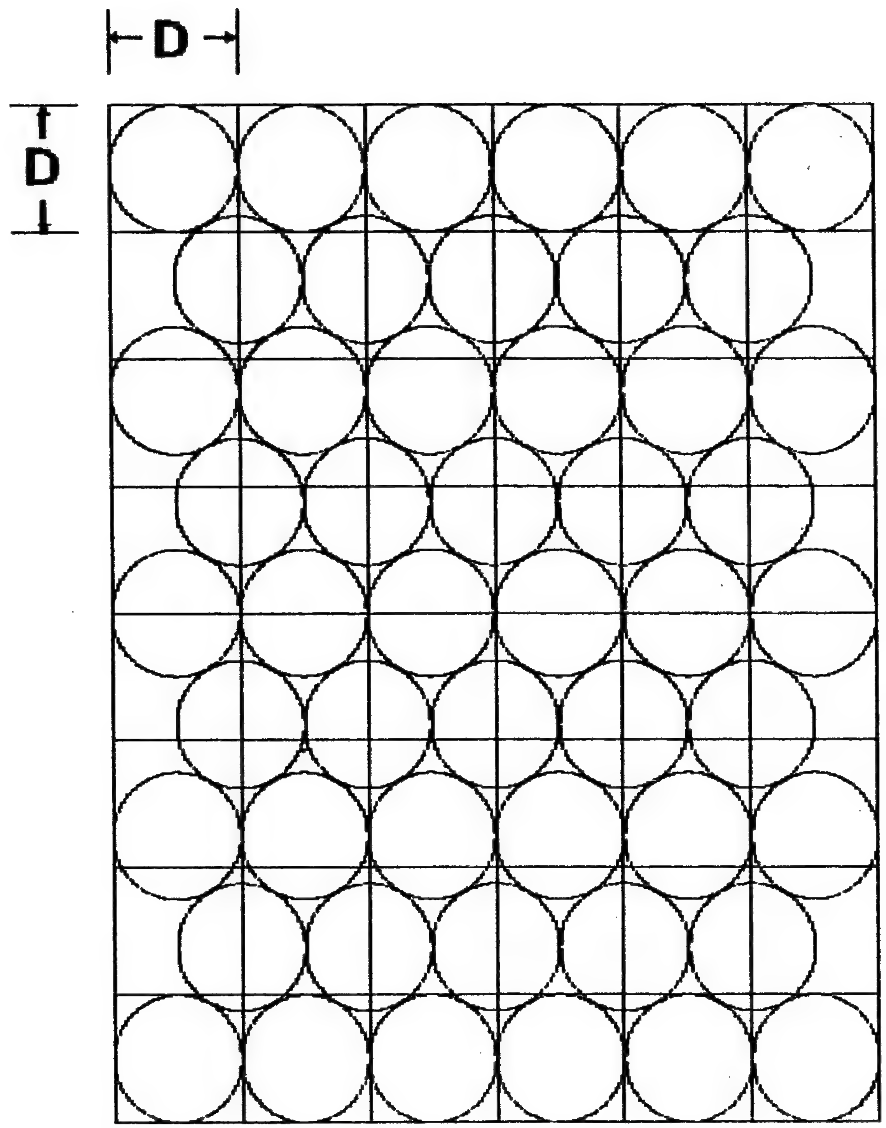
DRAWING NO.	ESTIMATOR	CHECKED BY
NA	W. T. Todd	P. Hutchins

Plastic Balls SUMMARY	QUANTITY NO. UNITS	UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
2" Plastic balls	16	Case	2.50	40.00	123	1968.00	2008.00
Subtotal				40.00		1968.00	2008.00
Location Adjustments			0.683	(12.68)	1.002	3.94	(8.74)
Sales Tax					4.5%	88.74	88.74
FICA / Insurance			20%	5.46			5.46
Subtotal							2093.46
Overhead	15%						314.02
Profit	10%						240.75
Performance Bond	1%						26.48
RAAP Support	6%						160.48
Contingency	10%						283.52
Construction Cost	per	Tank					3118.71
			8 buildings × 2	tanks	/ bldg		× 16
Total Construction Cost							$49,899.36
Source: Vendor Quote from Mid-America Plastics, Shakopee, MN							

ENG FORM 150 1 AUG 59 (ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

* U.S. GOVERNMENT PRINTING OFFICE . 1959 O—516146

Cover Water Dry Tanks



A_s = Surface Area = $6D \times 8D$

A_c = Circle Areas = $6 \times 9 \times \frac{\pi D^2}{4}$

C = % Coverage = $\frac{A_c}{A_s} \times 100$

$$C = \frac{6 \times 9 \times \frac{\pi D^2}{4}}{6D \times 8D} \times 100$$

$$C = \frac{9 \times \pi}{4 \times 8} \times 100 = \frac{9\pi}{32} \times 100$$

$$\underline{C = 88.4\%}$$

RSH 38 (3-63)

Water Dry House

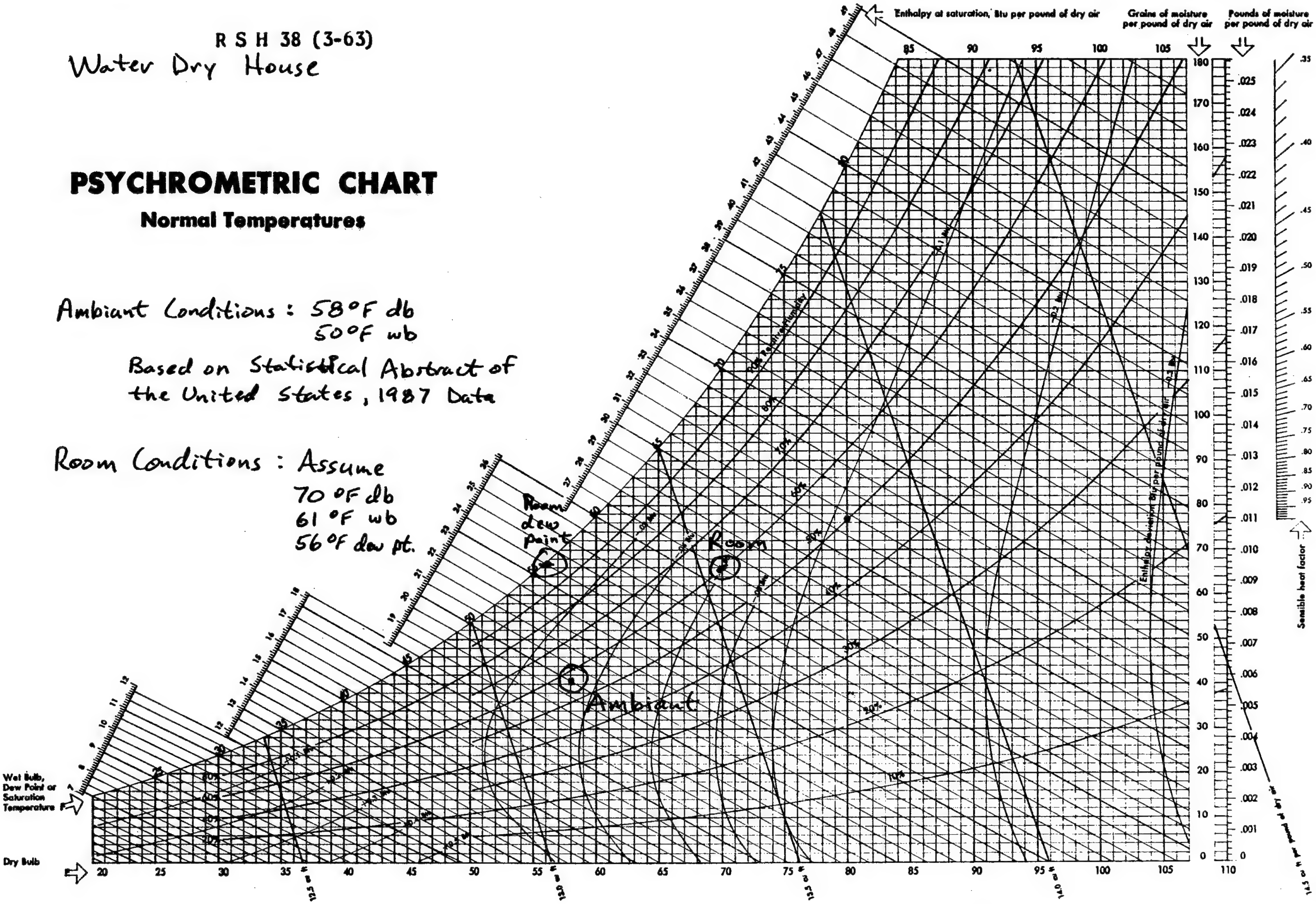
PSYCHROMETRIC CHART

Normal Temperatures

Ambiant Conditions : 58°F db
50°F wb

Based on Statistical Abstract of the United States, 1987 Data

Room Conditions : Assume
70 °F db
61 °F wb
56 °F dew pt.



Below 32 F, properties and enthalpy deviation lines are for ice.

Cover Water Dry Tanks

HUNTER **Telephone Call Confirmation**

800-468-1501

Project No. 2900379-000

Local ______ L.D. ______ Placed ______ Rec'd. ______ Date 6/4/90

B. Todd Conversed With Gary Lyons

Of Mid-America Plastics Regarding Hollow Plastic Spheres

Dia = 3/4"	1000	$39.40 /case	+ shipping
1 1/2"	1000	$143.50	
2"	500	$123.00	
4"	100	$203.00	

PolyPropylene or HDPE

90 Fumes reduction
88.3 Evap. redution
69.5 % Fuel savings

water with ether (small amounts) and alcohol

Gary will fax product info to me today.

Distribution:

MID-AMERICA PLASTICS, INC.
Plastic Specialists / Fabrication & Distribution
700 Industrial Circle So.
Shakopee, Minnesota 55379
612/445-7667 / FAX# 612/445-2974
800/468-1501

DATE: 4-6-90

TO: [illegible]

ATTN: Bill Todd X2653

Number of pages (Including this cover page): 2

REGARDING:

INFO on plastic Balls

SIGNATURE Gary Lyon
Mid-America Plastics, Inc.

MAP FAX #(612) 445-2974

6124452974

JUN- 4-90 MON 9:21 MID AMERICA PLSTCS P.02

THE ENERGY SAVERS and POLLUTION STOPPERS

PROVEN to Reduce Fuel Costs 89.5%
Reduces Fumes 90%
Reduces Evaporation 88.3%
ALL PLASTIC FLOATING SPHERES

Spheres float on surface of liquid in open tank and thereby greatly reduce the exposed liquid surface area — up to 90%. Dramatically diminishes objectionable fumes and odors. Blanket of spheres also insulates heated liquid reducing evaporation and heat requirements.

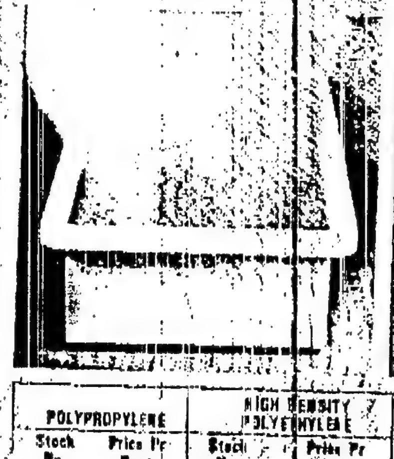
Ideal for plating tanks and similar open tank installations where the liquid surface can be covered with a blanket of spheres without impeding access to the tank for process purposes.

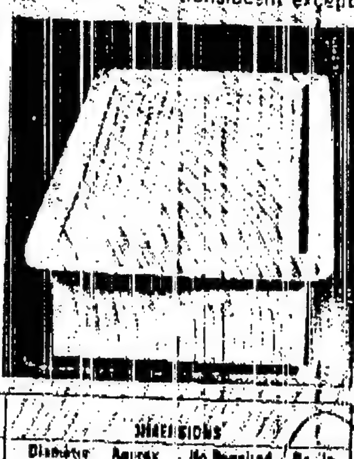
Spheres are hollow and will float on any liquid. Fully round. No welt or rim on which chemicals can deposit and being smooth they ensure a much tighter surface cover.

Polypropylene: non-toxic and able to withstand continuous working temperatures of 110°C (230°F) polypropylene is suitable for use in most known chemicals.

High Density Polyethylene generally suitable as above but with a continuous working temperature limitation of 80°C (176°F) softening point about 110°C (230°F). High density polyethylene has better chemical resistance to certain compounds like oil, and other hydro-carbons. Also less stress cracking at low temperatures than polypropylene. Color white translucent except 100 MM, black for outside use.

CUT HEAT LOSSES !
SAVE FACTORY MAINTENANCE !
IMPROVE SAFETY !
REMOVE FUMES AND ODORS !





APPLICATIONS

METAL WORKING — In Pickling and Chromating Tanks.
PLATING: Manual Chromium Line Reduces Spray Splashing.
PETROLEUM: Air Pollution, Noxious Odors, Waste Collection Pits.
FOOD: Reduces Vapor, Smell in Bacon Manufacturing.
POWER STATION: Surge Tank Reservoir of Hot Boiler — No Steam.
SWIMMING POOLS: Reduces Heat Loss.

POLYPROPYLENE		HIGH DENSITY POLYETHYLENE		DIMENSIONS			
Stock No.	Price Pr Case	Stock No.	Price Pr Case	Diameter MM	Approx. Size	No Required Per Sq Ft.	No. Per Case

mcp MID-AMERICA PLASTICS, INC.
Plastic Specialists / Fabrication & Distribution
700 Industrial Circle S. • Shakopee, Minnesota 55379
Phone 612 445-7867

BULK RATE

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT RAAP EEAP
Insulate Water Dry Tanks
DESIGNER W. T. Todd
CHECKER P. Hutchins

AEP NO.
SHEET 1 OF
DATE 6-6-90
DATE 6/12/90

ECO# FN-U-2

INSULATE FIBERGLASS WATER DRY TANKS

Assumptions:

1. The heat loss by radiation from the tank is negelected due to the low temperature difference and being indoors.

2. The heat loss by convection from the tank is negelected due to the still air conditions in the building.

3. The average room temperature is 70°F.

4. The tank temperature is 149°F. Waterland and Viar, Industrial Steam System Analysis.

5. The tank dimentions are 9 feet high with a 16 foot diameter.

6. The R-Value for the fiberglass tank is approximately equal to that of 1/4" aspestos cement siding.

Calculations:

$$Q_{sides} = U_{sides} A_{sides} \Delta T$$

$$U_{sides} = 1/R_{sides} = \frac{1}{R_{Tank} + R_{air}} = \frac{1}{0.21 + 0.68} = 1.12 \ \frac{Btu}{hr\text{-}ft^2\text{-}°F}$$

$$A_{sides} = 2\pi r h = 2 \times \pi \times 8ft \times 9ft = 452 \ ft^2$$

$$\Delta T = T_{Tank} - T_{air} = 149°F - 70°F = 79°F$$

FN-U-2

Water Dry Tank Insulation (Continued):

$$Q_{sides} = 1.12 \frac{Btu}{hr \cdot ft^2 \,°F} \times 452\ ft^2 \times 79°F = 39{,}993\ Btu/hr$$

Add 2" Fiberglass insulation wrap with metal jacketing to the sides of the tank.

$$U_{w/ins} = 1/R_{sides} = \frac{1}{0.21 + 6.9 + 0.68} = 0.13 \frac{Btu}{hr \cdot ft^2 \cdot °F}$$

$$Q_{w/ins} = 0.13 \frac{Btu}{hr \cdot ft^2 \cdot °F} \times 452\ ft^2 \times 79°F = 4{,}642\ Btu/hr$$

from ECO FN-S-1 calcs., the water dry tanks operate approximately 4320 hr/yr

Steam Savings:

$$Savings = (Q_{sides} - Q_{w/ins})\ Op.Hrs. \times \#tanks$$

$$= \left(39{,}993 \frac{Btu}{hr} - 4642 \frac{Btu}{hr}\right) * 4320 \frac{hr}{yr} \times 14\ tanks$$

$$Savings = 2138.0\ MBtu/yr$$

Coal Savings:

$$Energy\ Savings = 2138.0 \frac{MBtu}{Yr} \times 1.32 = \underline{2822 \frac{MBtu}{Yr}}$$

$$Cost\ Savings = \frac{MBtu}{Yr} \times 1.61\ \$/MBtu = \$\ \underline{4543}\ /yr$$

Elec. Price Diff Costs $= 2138.0 \frac{MBtu}{Yr} \times 1.11\ \$/MBtu = \$\ 2373\ /yr$ 3/91

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT Insulate W.D. Tanks
DESIGNER W. T. Todd
CHECKER

AEP NO
SHEET 3 OF
DATE
DATE

FN-U-2
Water Dry Tank Insulation (Continued):

Cost Savings = Coal \$ savings - Elec Price Diff costs
= \$4543 - 2373 = \$2170/yr

Savings = Coal \$ Savings -
\$/yr -

Construction Cost:

Project Cost = \$43,512

See Construction Cost Estimate Sheet

Simple Payback:

payback = Cost ÷ Savings
= \$43512 ÷ 2170 \$/yr = 20.1 years

CONSTRUCTION COST ESTIMATE	DATE PREPARED June 6, 1990	SHEET 4 OF

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: RADFORD ARMY AMMUNITION PLANT

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE:
- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.: NA | ESTIMATOR: W. Todd | CHECKED BY: P. Hutchins

Ins. W.D. Tanks SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
2" F.G. Insulation	480	SF	1.14	547.20	0.73	350.40	897.60
0.010" Aluminum Jacket	480	SF	2.86	1372.80	0.29	139.20	1512.00
Subtotal				1920.00		489.60	2409.60
Location Adjustments			0.683	(608.64)	1.002	0.98	(607.62)
Sales Tax					4.5%	22.08	22.08
FICA / Insurance			20%	262.27			262.27
Sub total				1573.63		512.66	2086.29
Overhead	15%						312.94
Profit	10%						239.92
Performance Bond	1%						26.39
RAAP Support	6%						159.93
Contingency	10%						282.55
Construction Cost per Tank							3,108.02
			Number of Fiberglass tanks				×14
Total Construction Cost							$43,512.28

Source: Means Mechanical Cost Data

ENG FORM 150 1 AUG 59 (ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

HUNTER **Telephone Call Confirmation**

Project No. 2900379000

Local L.D. Placed Rec'd. Date 6-5-90

W. Todd Conversed With Sid Jenkins

Of Jensco S+S Insulation Regarding Water Dry Tank Insulation

Given the conditions Sid suggested:

1" to 2" Fiberglass wrap @ \$2.50 to \$3.00 per SF

metal Jacketing @ \$1.00 per SF

Multiply by 2 for Military Specs.

The above values are installed costs.

Distribution:

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT RAAP EEAP
Electric Motors
DESIGNER T. Todd
CHECKER

AEP NO 2900379000
SHEET 1 OF 11
DATE
DATE

ECO # GP-B-1 REPLACE EXISTING MOTORS w/ ENERGY EFFICIENT MOTORS

Replacement of existing standard duty motors with energy efficient types was evaluated for various operating times.

A computer spreadsheet was developed to calculate the costs, energy savings, and paybacks for motors ranging from 1 hp to 300 hp. Page 2 shows the formulas which are contained in the spreadsheet. Pages 6 through 11 are printouts of the spreadsheet, on a per unit basis for hours of operation including:

8 hr/day	5 days/wk
8 hr/day	7 days/wk
16 hr/day	5 days/wk
16 hr/day	7 days/wk
24 hr/day	5 days/wk
24 hr/day	7 days/wk

Pages 3 & 4 summarize the costs and savings for all motors operating 24 hr/day, 5 days/wk which are from 10 hp to 150 hp.

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT RAAP LEAP
ELECTRIC MOTOR ECO'S
DESIGNER T. TODD
CHECKER

AEP NO 290 0379 000

DATE 5-1-90
DATE

ECO# GP-B-1

REPLACE EXISTING MOTORS W/ ENERGY-EFFICIENT MOTORS CALCULATION

ASSUMPTIONS MOTORS ARE EXPLOSION-PROOF FOR CLASS I, GROUP D & CLASS II, F&G 1800 RPM, 460 V, 3-PHASE

COSTS MATERIAL COSTS ARE FROM RELIANCE ELECTRIC COMPANY LIST PRICES, WITH A CONTRACTORS DISCOUNT FACTOR OF 0.75 FOR ENERGY-EFFICIENT MOTORS.

LABOR COSTS ARE FROM 1989 MEANS ELECTRICAL CATALOG FOR INSTALLATION OF MOTORS BY HP. THIS VALUE WAS MULTIPLIED BY 2 TO ACCOUNT FOR REMOVAL OF THE OLD MOTOR. THE LABOR FACTOR OF 0.683 WAS USED TO ADJUST FOR GEOGRAPHICAL LOCATION.

$$\text{NET COST (1990 \$)} = (1.045 \times \text{MAT'L} + 1.2 \times \text{LABOR}) \times 1.661$$

$$\text{SAVINGS} = \text{MOTOR HP} \times 0.746 \frac{\text{KW}}{\text{HP}} \times \left[\frac{1}{\text{S-D NOM. EFF.}} - \frac{1}{\text{E-E NOM. EFF.}}\right] \times \frac{\text{HRS}}{\text{YR}} \times \frac{\$0.03026}{\text{KWH}}$$

$$= \$/\text{YR}$$

$$\text{PAYBACK} = \frac{\text{NET COST (\$)}}{\text{SAVINGS (\$/YR)}} = \quad \text{YRS}$$

AP ENERGY EFFICIENT MOTOR PROJECTS
LENAME: RMOTEEV4
DATE: 12 JUNE 90

			CONTRACTOR	LABOR		REPLACE OPERATING MOTORS CALCULATION				
						ENERGY SAVINGS			COST SAVINGS	
MOTOR SIZE (HP)	TOTAL NO. OF MOTORS	NO. OF MOTORS OPERATING 3 SH,5 D/WK	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	REMOVE OR INSTALL MOTOR (1990$)	CONSTR COST (1990$)	PER MOTOR (KWH/YR)	TOTAL (KWH/YR)	(MMBTU/YR)	PER MOTOR ($/YR)	TOTAL ($/YR)
10	523	105	928	33	164,216	2,837	297,878	1,017	86	9,014
15	412	82	1,213	42	167,029	5,522	452,777	1,545	167	13,701
20	184	37	1,440	51	89,722	6,873	254,284	868	208	7,695
25	288	58	1,806	53	174,117	7,053	409,079	1,396	213	12,379
30	166	33	2,029	55	110,752	7,635	251,968	860	231	7,625
40	157	31	2,740	66	139,564	11,464	355,383	1,213	347	10,754
50	140	28	3,223	82	148,684	9,373	262,451	896	284	7,942
60	100	20	4,511	96	147,275	14,090	281,796	962	426	8,527
75	71	14	5,509	109	125,533	19,557	273,794	934	592	8,285
100	67	13	6,900	147	146,468	28,130	365,692	1,248	851	11,066
125	44	9	9,023	188	132,458	37,709	339,384	1,158	1,141	10,270
150	28	6	10,273	222	100,716	35,619	213,715	729	1,078	6,467
TOTAL					1,646,533		3,758,200	12,827		113,723

SUMPTION: 20% OF THE MOTORS OPERATE 24 HRS/DAY, 5 DAYS/WEEK

CONSTRUCTION COST ESTIMATE	DATE PREPARED 5-17-90	SHEET 4 OF 11

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: RADFORD ARMY AMMUNITION PLANT

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE:
- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.: ECO #GP-B-1

ESTIMATOR: T. Todd

CHECKED BY:

Motor Replacement SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
Replace standard duty motors with energy-efficient motors - 10 hp thru 150 hp	436	ea.	varies	26404		1027334	1053738
Sales Tax	4.5%					46230	46230
FICA / Insurance	20.0%			5281			5281
Subtotal				31685		1073564	1105249
Overhead	15.0%						165787
Profit	10.0%						127104
Performance bond	1.0%						13981
Hercules Support	6.0%						84727
Contingency 10	10.0%						149685
Construction Cost							1646533

ENG FORM 150 1 AUG 59 (ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

* U.S. GOVERNMENT PRINTING OFFICE

CONSTRUCTION COST ESTIMATE

DATE PREPARED 5-1-90

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: RADFORD ARMY AMMUNITION PLANT

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE

- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO. ECO # GP-B-1

ESTIMATOR T. TODD

CHECKED BY

Motor replacement SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
5 hp motor	1	ea	29	58	636	636	694
energy-efficient,							
explosion-proof							
(remove old, install new)							
Sales tax	4.5%					29	29
FICA / Insurance	20.0%			12			12
Subtotal				70		665	735
Overhead	15.0%						110
Profit	10.0%						85
Performance Bond	1.0%						9
Hercules Support	6.0%						56
Contingency	10.0%						100
Construction Cost							1095

GP-B-1

RAAP ENERGY EFFICIENT MOTOR PROJECTS
FILENAME: RMOTEE3
DATE: 8 MAY 90

	LIST PRICE	CONTRACTOR	LABOR		MAT'L & LABOR	EFFICIENCIES				REPLACE OPERATING MOTORS CALCULATION			
MOTOR SIZE (HP)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	REMOVE OR INSTALL MOTOR (MEANS 1989$)	REMOVE OR INSTALL MOTOR (1990$)	PRICE W/ MARKUPS (1990$)	RELIANCE STD MOTOR MIN. EFF. (%)	RELIANCE STD MOTOR NOM. EFF. (%)	RELIANCE EXP-PR XE MIN EFF. (%)	RELIANCE EXP-PR XE NOM EFF. (%)	ENERGY SAVINGS (KWH/YR)	REDUCED DEMAND (KW)	COST SAVINGS ($/YR)	SIMPLE PAYBACK (YRS)
1	690	518	43	29	921	74.0%	77.0%	82.5%	84.0%	168	0.1	5	181.3
1.5	724	543	43	29	961	75.5%	78.5%	84.0%	85.5%	243	0.1	7	130.9
2	760	570	43	29	1004	78.5%	81.5%	85.5%	86.5%	220	0.1	7	150.7
3	765	574	43	29	1010	75.5%	78.5%	87.5%	88.5%	670	0.3	20	49.8
5	848	636	43	29	1108	80.0%	82.5%	87.5%	88.5%	638	0.3	19	57.4
7.5	1078	809	46	31	1387	81.5%	84.0%	89.5%	90.2%	952	0.5	29	48.1
10	1237	928	49	33	1582	82.5%	85.5%	89.5%	90.2%	946	0.5	29	55.3
15	1617	1213	61	42	2061	82.5%	85.5%	91.0%	91.7%	1841	0.9	56	37.0
20	1920	1440	75	51	2453	84.0%	86.5%	91.7%	92.4%	2291	1.1	69	35,4
25	2408	1806	78	53	3037	85.5%	87.5%	91.7%	92.4%	2351	1.1	71	42.7
30	2705	2029	81	55	3395	86.5%	88.5%	92.4%	93.0%	2545	1.2	77	44.1
40	3653	2740	97	66	4554	86.5%	88.5%	93.0%	93.6%	3821	1.8	116	39.4
50	4297	3223	120	82	5372	88.5%	90.2%	93.0%	93.6%	3124	1.5	95	56.8
60	6014	4511	140	96	7449	88.5%	90.2%	94.1%	94.5%	4697	2.3	142	52.4
75	7345	5509	160	109	9071	88.5%	90.2%	94.5%	95.0%	6519	3.1	197	46.0
100	9200	6900	215	147	11397	88.5%	90.2%	95.0%	95.4%	9377	4.5	284	40.2
125	12030	9023	275	188	14888	88.5%	90.2%	95.4%	95.8%	12570	6.0	380	39.1
150	13697	10273	325	222	16981	90.2%	91.7%	95.8%	96.2%	11873	5.7	359	47.3
200	16651	12488	390	266	20630	91.7%	93.0%	95.8%	96.2%	11100	5.3	336	61.4
250	20342	15257	455	311	25150	93.0%	93.6%	95.8%	96.2%	11201	5.4	339	74.2
300	21438	16079	520	355	26605	93.0%	94.1%	96.2%	96.5%	12303	5.9	372	71.5

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST EFF)-(1/EN EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 8 HRS/DAY
5 DAYS/WK = 2080 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

GP-E-1 p. 7 of 11

RAAP ENERGY EFFICIENT MOTOR PROJECTS
FILENAME: RMOTEE3
DATE: 8 MAY 90

	LIST PRICE	CONTRACTOR	LABOR		MAT'L & LABOR	EFFICIENCIES				REPLACE OPERATING MOTORS CALCULATION			
MOTOR SIZE (HP)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	REMOVE OR INSTALL MOTOR (MEANS 1989$)	REMOVE OR INSTALL MOTOR (1990$)	PRICE W/ MARKUPS (1990$)	RELIANCE STD MOTOR MIN. EFF. (%)	RELIANCE STD MOTOR NOM. EFF. (%)	RELIANCE EXP-PR XE MIN EFF. (%)	RELIANCE EXP-PR XE NOM EFF. (%)	ENERGY SAVINGS (KWH/YR)	REDUCED DEMAND (KW)	COST SAVINGS ($/YR)	SIMPLE PAYBACK (YRS)
1	690	518	43	29	921	74.0%	77.0%	82.5%	84.0%	236	0.1	7	129.1
1.5	724	543	43	29	961	75.5%	78.5%	84.0%	85.5%	341	0.1	10	93.2
2	760	570	43	29	1004	78.5%	81.5%	85.5%	86.5%	309	0.1	9	107.4
3	765	574	43	29	1010	75.5%	78.5%	87.5%	88.5%	941	0.3	28	35.5
5	848	636	43	29	1100	80.0%	82.5%	87.5%	88.5%	895	0.3	27	40.9
7.5	1078	809	46	31	1387	81.5%	84.0%	89.5%	90.2%	1337	0.5	40	34.3
10	1237	928	49	33	1582	82.5%	85.5%	89.5%	90.2%	1328	0.5	40	39.4
15	1617	1213	61	42	2061	82.5%	85.5%	91.0%	91.7%	2584	0.9	78	26.4
20	1920	1440	75	51	2453	84.0%	86.5%	91.7%	92.4%	3216	1.1	97	25.2
25	2408	1806	78	53	3037	85.5%	87.5%	91.7%	92.4%	3300	1.1	100	30.4
30	2705	2029	81	55	3395	86.5%	88.5%	92.4%	93.0%	3573	1.2	108	31.4
40	3653	2740	97	66	4554	86.5%	88.5%	93.0%	93.6%	5365	1.8	162	28.1
50	4297	3223	120	82	5372	88.5%	90.2%	93.0%	93.6%	4386	1.5	133	40.5
60	6014	4511	140	96	7449	88.5%	90.2%	94.1%	94.5%	6593	2.3	200	37.3
75	7345	5509	160	109	9071	88.5%	90.2%	94.5%	95.0%	9152	3.1	277	32.8
100	9200	6900	215	147	11397	88.5%	90.2%	95.0%	95.4%	13163	4.5	398	28.6
125	12030	9023	275	188	14888	88.5%	90.2%	95.4%	95.8%	17646	6.0	534	27.9
150	13697	10273	325	222	16981	90.2%	91.7%	95.8%	96.2%	16668	5.7	504	33.7
200	16651	12488	390	266	20630	91.7%	93.0%	95.8%	96.2%	15583	5.3	472	43.8
250	20342	15257	455	311	25150	93.0%	93.6%	95.8%	96.2%	15725	5.4	476	52.9
300	21438	16079	520	355	26605	93.0%	94.1%	96.2%	96.5%	17272	5.9	523	50.9

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST EFF)-(1/EN EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 8 HRS/DAY
7 DAYS/WK = 2920 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

4P-B-1

RAAP ENERGY EFFICIENT MOTOR PROJECTS
FILENAME: RMOTEE3
DATE: 8 MAY 90

	LIST PRICE	CONTRACTOR	LABOR		MAT'L & LABOR	EFFICIENCIES				REPLACE OPERATING MOTORS CALCULATION			
MOTOR SIZE (HP)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	REMOVE OR INSTALL MOTOR (MEANS 1989$)	REMOVE OR INSTALL MOTOR (1990$)	PRICE W/ MARKUPS (1990$)	RELIANCE STD MOTOR MIN. EFF. (%)	RELIANCE STD MOTOR NOM. EFF. (%)	RELIANCE EXP-PR XE MIN EFF. (%)	RELIANCE EXP-PR XE NOM EFF. (%)	ENERGY SAVINGS (KWH/YR)	REDUCED DEMAND (KW)	COST SAVINGS ($/YR)	SIMPLE PAYBACK (YRS)
1	690	518	43	29	921	74.0%	77.0%	82.5%	84.0%	336	0.1	10	90.6
1.5	724	543	43	29	961	75.5%	78.5%	84.0%	85.5%	485	0.1	15	65.4
2	760	570	43	29	1004	78.5%	81.5%	85.5%	86.5%	440	0.1	13	75.4
3	765	574	43	29	1010	75.5%	78.5%	87.5%	88.5%	1340	0.3	41	24.9
5	848	636	43	29	1108	80.0%	82.5%	87.5%	88.5%	1275	0.3	39	28.7
7.5	1078	809	46	31	1387	81.5%	84.0%	89.5%	90.2%	1905	0.5	58	24.1
10	1237	928	49	33	1582	82.5%	85.5%	89.5%	90.2%	1891	0.5	57	27.6
15	1617	1213	61	42	2061	82.5%	85.5%	91.0%	91.7%	3681	0.9	111	18.5
20	1920	1440	75	51	2453	84.0%	86.5%	91.7%	92.4%	4582	1.1	139	17.7
25	2408	1806	78	53	3037	85.5%	87.5%	91.7%	92.4%	4702	1.1	142	21.3
30	2705	2029	81	55	3395	86.5%	88.5%	92.4%	93.0%	5090	1.2	154	22.0
40	3653	2740	97	66	4554	86.5%	88.5%	93.0%	93.6%	7643	1.8	231	19.7
50	4297	3223	120	82	5372	88.5%	90.2%	93.0%	93.6%	6249	1.5	189	28.4
60	6014	4511	140	96	7449	88.5%	90.2%	94.1%	94.5%	9393	2.3	284	26.2
75	7345	5509	160	109	9071	88.5%	90.2%	94.5%	95.0%	13038	3.1	395	23.0
100	9200	6900	215	147	11397	88.5%	90.2%	95.0%	95.4%	18753	4.5	567	20.1
125	12030	9023	275	188	14888	88.5%	90.2%	95.4%	95.8%	25140	6.0	761	19.6
150	13697	10273	325	222	16981	90.2%	91.7%	95.8%	96.2%	23746	5.7	719	23.6
200	16651	12488	390	266	20630	91.7%	93.0%	95.8%	96.2%	22200	5.3	672	30.7
250	20342	15257	455	311	25150	93.0%	93.6%	95.8%	96.2%	22402	5.4	678	37.1
300	21438	16079	520	355	26605	93.0%	94.1%	96.2%	96.5%	24606	5.9	745	35.7

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST EFF)-(1/EN EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 16 HRS/DAY
5 DAYS/WK = 4160 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

GP-B-1

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RAAP ENERGY EFFICIENT MOTOR PROJECTS
FILENAME: RMOTEE3
DATE: 8 MAY 90

	LIST PRICE	CONTRACTOR	LABOR		MAT'L & LABOR	EFFICIENCIES				REPLACE OPERATING MOTORS CALCULATION			
MOTOR SIZE (HP)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	REMOVE OR INSTALL MOTOR (MEANS 1989$)	REMOVE OR INSTALL MOTOR (1990$)	PRICE W/ MARKUPS (1990$)	RELIANCE STD MOTOR MIN. EFF. (%)	RELIANCE STD MOTOR NOM. EFF. (%)	RELIANCE EXP-PR XE MIN EFF. (%)	RELIANCE EXP-PR XE NOM EFF. (%)	ENERGY SAVINGS (KWH/YR)	REDUCED DEMAND (KW)	COST SAVINGS ($/YR)	SIMPLE PAYBACK (YRS)
1	690	518	43	29	921	74.0%	77.0%	82.5%	84.0%	471	0.1	14	64.6
1.5	724	543	43	29	961	75.5%	78.5%	84.0%	85.5%	682	0.1	21	46.6
2	760	570	43	29	1004	78.5%	81.5%	85.5%	86.5%	618	0.1	19	53.7
3	765	574	43	29	1010	75.5%	78.5%	87.5%	88.5%	1881	0.3	57	17.7
5	848	636	43	29	1108	80.0%	82.5%	87.5%	88.5%	1790	0.3	54	20.5
7.5	1078	809	46	31	1387	81.5%	84.0%	89.5%	90.2%	2674	0.5	81	17.1
10	1237	928	49	33	1582	82.5%	85.5%	89.5%	90.2%	2655	0.5	80	19.7
15	1617	1213	61	42	2061	82.5%	85.5%	91.0%	91.7%	5168	0.9	156	13.2
20	1920	1440	75	51	2453	84.0%	86.5%	91.7%	92.4%	6432	1.1	195	12.6
25	2408	1806	78	53	3037	85.5%	87.5%	91.7%	92.4%	6601	1.1	200	15.2
30	2705	2029	81	55	3395	86.5%	88.5%	92.4%	93.0%	7146	1.2	216	15.7
40	3653	2740	97	66	4554	86.5%	88.5%	93.0%	93.6%	10729	1.8	325	14.0
50	4297	3223	120	82	5372	88.5%	90.2%	93.0%	93.6%	8772	1.5	265	20.2
60	6014	4511	140	96	7449	88.5%	90.2%	94.1%	94.5%	13187	2.3	399	18.7
75	7345	5509	160	109	9071	88.5%	90.2%	94.5%	95.0%	18303	3.1	554	16.4
100	9200	6900	215	147	11397	88.5%	90.2%	95.0%	95.4%	26327	4.5	797	14.3
125	12030	9023	275	188	14808	88.5%	90.2%	95.4%	95.8%	35292	6.0	1068	13.9
150	13697	10273	325	222	16981	90.2%	91.7%	95.8%	96.2%	33336	5.7	1009	16.8
200	16651	12488	390	266	20630	91.7%	93.0%	95.8%	96.2%	31165	5.3	943	21.9
250	20342	15257	455	311	25150	93.0%	93.6%	95.8%	96.2%	31450	5.4	952	26.4
300	21438	16079	520	355	26605	93.0%	94.1%	96.2%	96.5%	34544	5.9	1045	25.5

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST EFF)-(1/EN EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 16 HRS/DAY
7 DAYS/WK = 5840 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

GP-B-1

RAAP ENERGY EFFICIENT MOTOR PROJECTS
FILENAME: RMOTEE3
DATE: 8 MAY 90

	LIST PRICE	CONTRACTOR	LABOR		MAT'L & LABOR	EFFICIENCIES				REPLACE OPERATING MOTORS CALCULATION			
MOTOR SIZE (HP)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	REMOVE OR INSTALL MOTOR (MEANS 1989$)	REMOVE OR INSTALL MOTOR (1990$)	PRICE W/ MARKUPS (1990$)	RELIANCE STD MOTOR MIN. EFF. (%)	RELIANCE STD MOTOR NOM. EFF. (%)	RELIANCE EXP-PR XE MIN EFF. (%)	RELIANCE EXP-PR XE NOM EFF. (%)	ENERGY SAVINGS (KWH/YR)	REDUCED DEMAND (KW)	COST SAVINGS ($/YR)	SIMPLE PAYBACK (YRS)
1	690	518	43	29	921	74.0%	77.0%	82.5%	84.0%	504	0.1	15	60.4
1.5	724	543	43	29	961	75.5%	78.5%	84.0%	85.5%	728	0.1	22	43.6
2	760	570	43	29	1004	78.5%	81.5%	85.5%	86.5%	660	0.1	20	50.2
3	765	574	43	29	1010	75.5%	78.5%	87.5%	88.5%	2010	0.3	61	16.6
5	848	636	43	29	1108	80.0%	82.5%	87.5%	88.5%	1913	0.3	58	19.1
7.5	1078	809	46	31	1387	81.5%	84.0%	89.5%	90.2%	2857	0.5	86	16.0
10	1237	928	49	33	1582	82.5%	85.5%	89.5%	90.2%	2837	0.5	86	18.4
15	1617	1213	61	42	2061	82.5%	85.5%	91.0%	91.7%	5522	0.9	167	12.3
20	1920	1440	75	51	2453	84.0%	86.5%	91.7%	92.4%	6873	1.1	208	11.8
25	2408	1806	78	53	3037	85.5%	87.5%	91.7%	92.4%	7053	1.1	213	14.2
30	2705	2029	81	55	3395	86.5%	88.5%	92.4%	93.0%	7635	1.2	231	14.7
40	3653	2740	97	66	4554	86.5%	88.5%	93.0%	93.6%	11464	1.8	347	13.1
50	4297	3223	120	82	5372	88.5%	90.2%	93.0%	93.6%	9373	1.5	284	18.9
60	6014	4511	140	96	7449	88.5%	90.2%	94.1%	94.5%	14090	2.3	426	17.5
75	7345	5509	160	109	9071	88.5%	90.2%	94.5%	95.0%	19557	3.1	592	15.3
100	9200	6900	215	147	11397	88.5%	90.2%	95.0%	95.4%	28130	4.5	851	13.4
125	12030	9023	275	188	14888	88.5%	90.2%	95.4%	95.8%	37709	6.0	1141	13.0
150	13697	10273	325	222	16981	90.2%	91.7%	95.8%	96.2%	35619	5.7	1078	15.8
200	16651	12488	390	266	20630	91.7%	93.0%	95.8%	96.2%	33300	5.3	1008	20.5
250	20342	15257	455	311	25150	93.0%	93.6%	95.8%	96.2%	33604	5.4	1017	24.7
300	21438	16079	520	355	26605	93.0%	94.1%	96.2%	96.5%	36910	5.9	1117	23.8

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST EFF)-(1/EN EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 24 HRS/DAY
5 DAYS/WK = 6240 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

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RAAP ENERGY EFFICIENT MOTOR PROJECTS
FILENAME: RMOTEE3
DATE: 8 MAY 90

	LIST PRICE	CONTRACTOR	LABOR		MAT'L & LABOR	EFFICIENCIES				REPLACE OPERATING MOTORS CALCULATION			
MOTOR SIZE (HP)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	REMOVE OR INSTALL MOTOR (MEANS 1989$)	REMOVE OR INSTALL MOTOR (1990$)	PRICE W/ MARKUPS (1990$)	RELIANCE STD MOTOR MIN. EFF. (%)	RELIANCE STD MOTOR NOM. EFF. (%)	RELIANCE EXP-PR XE MIN EFF. (%)	RELIANCE EXP-PR XE NOM EFF. (%)	ENERGY SAVINGS (KWH/YR)	REDUCED DEMAND (KW)	COST SAVINGS ($/YR)	SIMPLE PAYBACK (YRS)
1	690	518	43	29	921	74.0%	77.0%	82.5%	84.0%	707	0.1	21	43.0
1.5	724	543	43	29	961	75.5%	78.5%	84.0%	85.5%	1022	0.1	31	31.1
2	760	570	43	29	1004	78.5%	81.5%	85.5%	86.5%	927	0.1	28	35.8
3	765	574	43	29	1010	75.5%	78.5%	87.5%	88.5%	2822	0.3	85	11.8
5	848	636	43	29	1108	80.0%	82.5%	87.5%	88.5%	2685	0.3	81	13.6
7.5	1078	809	46	31	1387	81.5%	84.0%	89.5%	90.2%	4011	0.5	121	11.4
10	1237	928	49	33	1582	82.5%	85.5%	89.5%	90.2%	3983	0.5	121	13.1
15	1617	1213	61	42	2061	82.5%	85.5%	91.0%	91.7%	7752	0.9	235	8.8
20	1920	1440	75	51	2453	84.0%	86.5%	91.7%	92.4%	9648	1.1	292	8.4
25	2408	1806	78	53	3037	85.5%	87.5%	91.7%	92.4%	9901	1.1	300	10.1
30	2705	2029	81	55	3395	86.5%	88.5%	92.4%	93.0%	10719	1.2	324	10.5
40	3653	2740	97	66	4554	86.5%	88.5%	93.0%	93.6%	16094	1.8	487	9.4
50	4297	3223	120	82	5372	88.5%	90.2%	93.0%	93.6%	13159	1.5	398	13.5
60	6014	4511	140	96	7449	88.5%	90.2%	94.1%	94.5%	19780	2.3	599	12.4
75	7345	5509	160	109	9071	88.5%	90.2%	94.5%	95.0%	27455	3.1	831	10.9
100	9200	6900	215	147	11397	88.5%	90.2%	95.0%	95.4%	39490	4.5	1195	9.5
125	12030	9023	275	188	14888	88.5%	90.2%	95.4%	95.8%	52938	6.0	1602	9.3
150	13697	10273	325	222	16981	90.2%	91.7%	95.8%	96.2%	50004	5.7	1513	11.2
200	16651	12488	390	266	20630	91.7%	93.0%	95.8%	96.2%	46748	5.3	1415	14.6
250	20342	15257	455	311	25150	93.0%	93.6%	95.8%	96.2%	47174	5.4	1427	17.6
300	21438	16079	520	355	26605	93.0%	94.1%	96.2%	96.5%	51815	5.9	1568	17.0

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST EFF)-(1/EN EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 24 HRS/DAY
7 DAYS/WK = 8760 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT RAAP EEAP
Electric Motors
DESIGNER T. Todd
CHECKER

AEP NO. 290 0379 000
SHEET 1 OF 8
DATE
DATE

ECO # GP-B-2 INSTALL ENERGY EFFICIENT MOTORS UPON FAILURE AND FOR NEW MOTORS

A computer spreadsheet was developed to calculate the costs, energy savings, and paybacks for motors ranging from 1 hp to 300 hp. Page 2 shows the calculations that are contained in the spreadsheet. Pages 3 through 8 are printouts of the spreadsheet on a per unit basis for hours of operation ranging from 8 hr/day, 5 days/wk to 24 hr/day, 7 days/wk.

REYNOLDS. SMITH AND HILLS ARCHITECTS • ENGINEERS • PLANNERS INCORPORATED	SUBJECT RAAP EEAP ELECTRIC MOTOR ECO'S	AEP NO 290 0379 000	
	DESIGNER T. TODD	SHEET 2 OF 8	DATE 5-1-90
	CHECKER	DATE	

ECO # GP-B-2

ENERGY-EFFICIENT MOTOR INSTALLATION UPON FAILURE & FOR NEW MOTORS

ASSUMPTIONS MOTORS ARE EXPLOSION PROOF FOR CLASS I, GROUP D
CLASS II, GROUPS F & G
1800 RPM, 460 VOLT, 3-PHASE

COSTS

NO ADD'L LABOR IS INCLUDED FOR REMOVAL & INSTALLATION SINCE A MOTOR WILL BE REPLACED OR INSTALLED IN BOTH CASES.

STANDARD-DUTY: MATERIAL COSTS ARE FROM RELIANCE ELECTRIC COMPANY LIST PRICES, WITH A CONTRACTORS DISCOUNT FACTOR OF 0.65 FOR STANDARD-DUTY MOTORS.

TOTAL STD-DUTY COST = MAT'L × 1.045 × 1.507

ENERGY-EFFICIENT: MATERIAL COSTS ARE FROM RELIANCE ELECTRIC COMPANY LIST PRICES, WITH A CONTRACTORS DISCOUNT FACTOR OF 0.75 FOR ENERGY-EFFICIENT MOTORS.

TOTAL ENERGY-EFF COST = MAT'L × 1.045 × 1.507

NET COST (1990 $) = TOTAL ENERGY-EFF COST − TOTAL STD-DUTY COST

$$\text{SAVINGS} = \text{MOTOR HP} \times 0.746\,\frac{\text{KW}}{\text{HP}} \times \left[\frac{1}{\text{S-D NOM. EFF.}} - \frac{1}{\text{E-E NOM. EFF.}}\right] \times \frac{\text{HRS}}{\text{YR}} \times \frac{\$0.03026}{\text{KWH}}$$

$= \$/\text{YR}$

$$\text{PAYBACK} = \frac{\text{NET COST } (\$)}{\text{SAVINGS } (\$/\text{YR})} = \text{YRS}$$

RAAP ENERGY EFFICIENT MOTOR PROJECTS
FILENAME: RMOTSE3
DATE: 8 MAY 90

	LIST PRICES		CONTRACTORS PRICE		PRICES WITH MARKUPS		EFFICIENCIES				STANDARD VS ENERGY EFF CALCULATION			
MOTOR SIZE (HP)	RELIANCE STD DUTY EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE STD DUTY EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE STD DUTY EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE STD MOTOR MIN. EFF. (%)	RELIANCE STD MOTOR NOM. EFF. (%)	RELIANCE EXP-PR XE MIN EFF. (%)	RELIANCE EXP-PR XE NOM EFF. (%)	ENERGY SAVINGS (KWH/YR)	REDUCED DEMAND (KW)	COST SAVINGS ($/YR)	SIMPLE PAYBACK (YRS)
1	512	690	333	518	524	815	74.0%	77.0%	82.5%	84.0%	168	0.1	5	57.2
1.5	546	724	355	543	559	855	75.5%	78.5%	84.0%	85.5%	243	0.1	7	40.3
2	578	760	376	570	592	898	78.5%	81.5%	85.5%	86.5%	220	0.1	7	45.9
3	536	765	348	574	549	904	75.5%	78.5%	87.5%	88.5%	670	0.3	20	17.5
5	584	848	380	636	598	1002	80.0%	82.5%	87.5%	88.5%	638	0.3	19	20.9
7.5	754	1078	490	809	772	1273	81.5%	84.0%	89.5%	90.2%	952	0.5	29	17.4
10	884	1237	575	928	905	1461	82.5%	85.5%	89.5%	90.2%	946	0.5	29	19.4
15	1186	1617	771	1213	1214	1910	82.5%	85.5%	91.0%	91.7%	1841	0.9	56	12.5
20	1400	1920	910	1440	1433	2268	84.0%	86.5%	91.7%	92.4%	2291	1.1	69	12.0
25	1740	2408	1131	1806	1781	2844	85.5%	87.5%	91.7%	92.4%	2351	1.1	71	14.9
30	2004	2705	1303	2029	2051	3195	86.5%	88.5%	92.4%	93.0%	2545	1.2	77	14.8
40	2727	3653	1773	2740	2791	4315	86.5%	88.5%	93.0%	93.6%	3821	1.8	116	13.2
50	3282	4297	2133	3223	3360	5075	88.5%	90.2%	93.0%	93.6%	3124	1.5	95	18.1
60	4659	6014	3028	4511	4769	7103	88.5%	90.2%	94.1%	94.5%	4697	2.3	142	16.4
75	5708	7345	3710	5509	5843	8675	88.5%	90.2%	94.5%	95.0%	6519	3.1	197	14.4
100	7041	9200	4577	6900	7207	10866	88.5%	90.2%	95.0%	95.4%	9377	4.5	284	12.9
125	9095	12030	5912	9023	9310	14209	88.5%	90.2%	95.4%	95.8%	12570	6.0	380	12.9
150	10701	13697	6956	10273	10954	16178	90.2%	91.7%	95.8%	96.2%	11873	5.7	359	14.5
200	12597	16651	8188	12488	12895	19667	91.7%	93.0%	95.8%	96.2%	11100	5.3	336	20.2
250	15443	20342	10038	15257	15808	24026	93.0%	93.6%	95.8%	96.2%	11201	5.4	339	24.2
300	17726	21438	11522	16079	18145	25321	93.0%	94.1%	96.2%	96.5%	12303	5.9	372	19.3

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST NOM EFF)-(1/EE NOM EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 8 HRS/DAY
5 DAYS/WK = 2080 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

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RAAP ENERGY EFFICIENT MOTOR PROJECTS
FILENAME: RMOTSE3
DATE: 8 MAY 90

MOTOR SIZE (HP)	LIST PRICES: RELIANCE STD DUTY EXP-PROOF (1990$)	LIST PRICES: RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	CONTRACTORS PRICE: RELIANCE STD DUTY EXP-PROOF (1990$)	CONTRACTORS PRICE: RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	PRICES WITH MARKUPS: RELIANCE STD DUTY EXP-PROOF (1990$)	PRICES WITH MARKUPS: RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	EFFICIENCIES: RELIANCE STD MOTOR MIN. EFF. (%)	EFFICIENCIES: RELIANCE STD MOTOR NOM. EFF. (%)	EFFICIENCIES: RELIANCE EXP-PR XE MIN EFF. (%)	EFFICIENCIES: RELIANCE EXP-PR XE NOM EFF. (%)	STANDARD VS ENERGY EFF CALCULATION: ENERGY SAVINGS (KWH/YR)	REDUCED DEMAND (KW)	COST SAVINGS ($/YR)	SIMPLE PAYBACK (YRS)
1	512	690	333	518	524	815	74.0%	77.0%	82.5%	84.0%	236	0.1	7	40.8
1.5	546	724	355	543	559	855	75.5%	78.5%	84.0%	85.5%	341	0.1	10	28.7
2	578	760	376	570	592	898	78.5%	81.5%	85.5%	86.5%	309	0.1	9	32.7
3	536	765	348	574	549	904	75.5%	78.5%	87.5%	88.5%	941	0.3	28	12.5
5	584	840	380	636	598	1002	80.0%	82.5%	87.5%	88.5%	895	0.3	27	14.9
7.5	754	1078	490	809	772	1273	81.5%	84.0%	89.5%	90.2%	1337	0.5	40	12.4
10	884	1237	575	928	905	1461	82.5%	85.5%	89.5%	90.2%	1328	0.5	40	13.8
15	1186	1617	771	1213	1214	1910	82.5%	85.5%	91.0%	91.7%	2584	0.9	78	8.9
20	1400	1920	910	1440	1433	2268	84.0%	86.5%	91.7%	92.4%	3216	1.1	97	8.6
25	1740	2408	1131	1806	1781	2844	85.5%	87.5%	91.7%	92.4%	3300	1.1	100	10.6
30	2004	2705	1303	2029	2051	3195	86.5%	88.5%	92.4%	93.0%	3573	1.2	108	10.6
40	2727	3653	1773	2740	2791	4315	86.5%	88.5%	93.0%	93.6%	5365	1.8	162	9.4
50	3282	4297	2133	3223	3360	5075	88.5%	90.2%	93.0%	93.6%	4386	1.5	133	12.9
60	4659	6014	3028	4511	4769	7103	88.5%	90.2%	94.1%	94.5%	6593	2.3	200	11.7
75	5708	7345	3710	5509	5843	8675	88.5%	90.2%	94.5%	95.0%	9152	3.1	277	10.2
100	7041	9200	4577	6900	7207	10866	88.5%	90.2%	95.0%	95.4%	13163	4.5	398	9.2
125	9095	12030	5912	9023	9310	14209	88.5%	90.2%	95.4%	95.8%	17646	6.0	534	9.2
150	10701	13697	6956	10273	10954	16178	90.2%	91.7%	95.8%	96.2%	16668	5.7	504	10.4
200	12597	16651	8188	12488	12895	19667	91.7%	93.0%	95.8%	96.2%	15583	5.3	472	14.4
250	15443	20342	10038	15257	15808	24026	93.0%	93.6%	95.8%	96.2%	15725	5.4	476	17.3
300	17726	21438	11522	16079	18145	25321	93.0%	94.1%	96.2%	96.5%	17272	5.9	523	13.7

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST NOM EFF)-(1/EE NOM EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 8 HRS/DAY
7 DAYS/WK = 2920 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

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RAAP ENERGY EFFICIENT MOTOR PROJECTS
FILENAME: RMOTSE3
DATE: 8 MAY 90

	LIST PRICES		CONTRACTORS PRICE		PRICES WITH MARKUPS		EFFICIENCIES				STANDARD VS ENERGY EFF CALCULATION			
MOTOR SIZE (HP)	RELIANCE STD DUTY EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE STD DUTY EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE STD DUTY EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE STD MOTOR MIN. EFF. (%)	RELIANCE STD MOTOR NOM. EFF. (%)	RELIANCE EXP-PR XE MIN EFF. (%)	RELIANCE EXP-PR XE NOM EFF. (%)	ENERGY SAVINGS (KWH/YR)	REDUCED DEMAND (KW)	COST SAVINGS ($/YR)	SIMPLE PAYBACK (YRS)
1	512	690	333	518	524	815	74.0%	77.0%	82.5%	84.0%	336	0.1	10	28.6
1.5	546	724	355	543	559	855	75.5%	78.5%	84.0%	85.5%	485	0.1	15	20.2
2	578	760	376	570	592	898	78.5%	81.5%	85.5%	86.5%	440	0.1	13	23.0
3	536	765	348	574	549	904	75.5%	78.5%	87.5%	88.5%	1340	0.3	41	8.8
5	584	848	380	636	598	1002	80.0%	82.5%	87.5%	88.5%	1275	0.3	39	10.5
7.5	754	1078	490	809	772	1273	81.5%	84.0%	89.5%	90.2%	1905	0.5	58	8.7
10	884	1237	575	928	905	1461	82.5%	85.5%	89.5%	90.2%	1891	0.5	57	9.7
15	1186	1617	771	1213	1214	1910	82.5%	85.5%	91.0%	91.7%	3681	0.9	111	6.2
20	1400	1920	910	1440	1433	2268	84.0%	86.5%	91.7%	92.4%	4582	1.1	139	6.0
25	1740	2408	1131	1806	1781	2844	85.5%	87.5%	91.7%	92.4%	4702	1.1	142	7.5
30	2004	2705	1303	2029	2051	3195	86.5%	88.5%	92.4%	93.0%	5090	1.2	154	7.4
40	2727	3653	1773	2740	2791	4315	86.5%	88.5%	93.0%	93.6%	7643	1.8	231	6.6
50	3282	4297	2133	3223	3360	5075	88.5%	90.2%	93.0%	93.6%	6249	1.5	189	9.1
60	4659	6014	3028	4511	4769	7103	88.5%	90.2%	94.1%	94.5%	9393	2.3	284	8.2
75	5708	7345	3710	5509	5843	8675	88.5%	90.2%	94.5%	95.0%	13038	3.1	395	7.2
100	7041	9200	4577	6900	7207	10866	88.5%	90.2%	95.0%	95.4%	18753	4.5	567	6.4
125	9095	12030	5912	9023	9310	14209	88.5%	90.2%	95.4%	95.8%	25140	6.0	761	6.4
150	10701	13697	6956	10273	10954	16178	90.2%	91.7%	95.8%	96.2%	23746	5.7	719	7.3
200	12597	16651	8188	12488	12895	19667	91.7%	93.0%	95.8%	96.2%	22200	5.3	672	10.1
250	15443	20342	10038	15257	15808	24026	93.0%	93.6%	95.8%	96.2%	22402	5.4	678	12.1
300	17726	21438	11522	16079	18145	25321	93.0%	94.1%	96.2%	96.5%	24606	5.9	745	9.6

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST NOM EFF)-(1/EE NOM EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 16 HRS/DAY
5 DAYS/WK = 4160 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

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RAAP ENERGY EFFICIENT MOTOR PROJECTS

FILENAME: RMOTSE3
DATE: 8 MAY 90

	LIST PRICES		CONTRACTORS PRICE		PRICES WITH MARKUPS		EFFICIENCIES				STANDARD VS ENERGY EFF CALCULATION			
MOTOR SIZE (HP)	RELIANCE STD DUTY EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE STD DUTY EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE STD DUTY EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE STD MOTOR MIN. EFF. (%)	RELIANCE STD MOTOR NOM. EFF. (%)	RELIANCE EXP-PR XE MIN EFF. (%)	RELIANCE EXP-PR XE NOM EFF. (%)	ENERGY SAVINGS (KWH/YR)	REDUCED DEMAND (KW)	COST SAVINGS ($/YR)	SIMPLE PAYBACK (YRS)
1	512	690	333	518	524	815	74.0%	77.0%	82.5%	84.0%	471	0.1	14	20.4
1.5	546	724	355	543	559	855	75.5%	78.5%	84.0%	85.5%	682	0.1	21	14.4
2	578	760	376	570	592	898	78.5%	81.5%	85.5%	86.5%	618	0.1	19	16.4
3	536	765	348	574	549	984	75.5%	78.5%	87.5%	88.5%	1881	0.3	57	6.2
5	584	848	380	636	598	1002	80.0%	82.5%	87.5%	88.5%	1790	0.3	54	7.5
7.5	754	1078	490	809	772	1273	81.5%	84.0%	89.5%	90.2%	2674	0.5	81	6.2
10	884	1237	575	928	905	1461	82.5%	85.5%	89.5%	90.2%	2655	0.5	80	6.9
15	1186	1617	771	1213	1214	1910	82.5%	85.5%	91.0%	91.7%	5160	0.9	156	4.4
20	1400	1920	910	1440	1433	2268	84.0%	86.5%	91.7%	92.4%	6432	1.1	195	4.3
25	1740	2408	1131	1806	1781	2844	85.5%	87.5%	91.7%	92.4%	6601	1.1	200	5.3
30	2004	2705	1303	2029	2051	3195	86.5%	88.5%	92.4%	93.0%	7146	1.2	216	5.3
40	2727	3653	1773	2740	2791	4315	86.5%	88.5%	93.0%	93.6%	10729	1.8	325	4.7
50	3282	4297	2133	3223	3360	5075	88.5%	90.2%	93.0%	93.6%	8772	1.5	265	6.5
60	4659	6014	3028	4511	4769	7103	88.5%	90.2%	94.1%	94.5%	13187	2.3	399	5.8
75	5708	7345	3710	5509	5843	8675	88.5%	90.2%	94.5%	95.0%	18303	3.1	554	5.1
100	7041	9200	4577	6900	7207	10866	88.5%	90.2%	95.0%	95.4%	26327	4.5	797	4.6
125	9095	12030	5912	9023	9310	14209	88.5%	90.2%	95.4%	95.8%	35292	6.0	1068	4.6
150	10701	13697	6956	10273	10954	16178	90.2%	91.7%	95.8%	96.2%	33336	5.7	1009	5.2
200	12597	16651	8188	12488	12895	19667	91.7%	93.0%	95.8%	96.2%	31165	5.3	943	7.2
250	15443	20342	10038	15257	15808	24026	93.0%	93.6%	95.8%	96.2%	31450	5.4	952	8.6
300	17726	21438	11522	16079	18145	25321	93.0%	94.1%	96.2%	96.5%	34544	5.9	1045	6.9

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST NOM EFF)-(1/EE NOM EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 16 HRS/DAY
7 DAYS/WK = 5840 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

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RAAP ENERGY EFFICIENT MOTOR PROJECTS
FILENAME: RMOTSE3
DATE: 8 MAY 90

	LIST PRICES		CONTRACTORS PRICE		PRICES WITH MARKUPS		EFFICIENCIES				STANDARD VS ENERGY EFF CALCULATION			
MOTOR SIZE (HP)	RELIANCE STD DUTY EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE STD DUTY EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE STD DUTY EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE STD MOTOR MIN. EFF. (%)	RELIANCE STD MOTOR NOM. EFF. (%)	RELIANCE EXP-PR XE MIN EFF. (%)	RELIANCE EXP-PR XE NOM EFF. (%)	ENERGY SAVINGS (KWH/YR)	REDUCED DEMAND (KW)	COST SAVINGS ($/YR)	SIMPLE PAYBACK (YRS)
1	512	690	333	518	524	815	74.0%	77.0%	82.5%	84.0%	504	0.1	15	19.1
1.5	546	724	355	543	559	855	75.5%	78.5%	84.0%	85.5%	728	0.1	22	13.4
2	578	760	376	570	592	898	78.5%	81.5%	85.5%	86.5%	660	0.1	20	15.3
3	536	765	348	574	549	904	75.5%	78.5%	87.5%	88.5%	2010	0.3	61	5.8
5	584	848	380	636	598	1002	80.0%	82.5%	87.5%	88.5%	1913	0.3	58	7.0
7.5	754	1078	490	809	772	1273	81.5%	84.0%	89.5%	90.2%	2857	0.5	86	5.8
10	884	1237	575	928	905	1461	82.5%	85.5%	89.5%	90.2%	2837	0.5	86	6.5
15	1186	1617	771	1213	1214	1910	82.5%	85.5%	91.0%	91.7%	5522	0.9	167	4.2
20	1400	1920	910	1440	1433	2268	84.0%	86.5%	91.7%	92.4%	6873	1.1	208	4.0
25	1740	2408	1131	1806	1781	2844	85.5%	87.5%	91.7%	92.4%	7053	1.1	213	5.0
30	2004	2705	1303	2029	2051	3195	86.5%	88.5%	92.4%	93.0%	7635	1.2	231	4.9
40	2727	3653	1773	2740	2791	4315	86.5%	88.5%	93.0%	93.6%	11464	1.8	347	4.4
50	3282	4297	2133	3223	3360	5075	88.5%	90.2%	93.0%	93.6%	9373	1.5	284	6.0
60	4659	6014	3028	4511	4769	7103	88.5%	90.2%	94.1%	94.5%	14090	2.3	426	5.5
75	5708	7345	3710	5509	5843	8675	88.5%	90.2%	94.5%	95.0%	19557	3.1	592	4.8
100	7041	9200	4577	6900	7207	10866	88.5%	90.2%	95.0%	95.4%	20130	4.5	851	4.3
125	9095	12030	5912	9023	9310	14209	88.5%	90.2%	95.4%	95.8%	37709	6.0	1141	4.3
150	10701	13697	6956	10273	10954	16178	90.2%	91.7%	95.8%	96.2%	35619	5.7	1078	4.8
200	12597	16651	8188	12488	12895	19667	91.7%	93.0%	95.8%	96.2%	33300	5.3	1008	6.7
250	15443	20342	10038	15257	15008	24026	93.0%	93.6%	95.8%	96.2%	33604	5.4	1017	8.1
300	17726	21438	11522	16079	18145	25321	93.0%	94.1%	96.2%	96.5%	36910	5.9	1117	6.4

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST NOM EFF)-(1/EE NOM EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 24 HRS/DAY
5 DAYS/WK = 6240 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

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RAAP ENERGY EFFICIENT MOTOR PROJECTS
FILENAME: RMOTSE3
DATE: 8 MAY 90

	LIST PRICES		CONTRACTORS PRICE		PRICES WITH MARKUPS		EFFICIENCIES				STANDARD VS ENERGY EFF CALCULATION			
MOTOR SIZE (HP)	RELIANCE STD DUTY EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE STD DUTY EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE STD DUTY EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE STD MOTOR MIN. EFF. (%)	RELIANCE STD MOTOR NOM. EFF. (%)	RELIANCE EXP-PR XE MIN EFF. (%)	RELIANCE EXP-PR XE NOM EFF. (%)	ENERGY SAVINGS (KWH/YR)	REDUCED DEMAND (KW)	COST SAVINGS ($/YR)	SIMPLE PAYBACK (YRS)
1	512	690	333	518	524	815	74.0%	77.0%	82.5%	84.0%	707	0.1	21	13.6
1.5	546	724	355	543	559	855	75.5%	78.5%	84.0%	85.5%	1022	0.1	31	9.6
2	578	760	376	570	592	898	78.5%	81.5%	85.5%	86.5%	927	0.1	28	10.9
3	536	765	348	574	549	904	75.5%	78.5%	87.5%	88.5%	2822	0.3	85	4.2
5	584	848	380	636	598	1002	80.0%	82.5%	87.5%	88.5%	2685	0.3	81	5.0
7.5	754	1078	490	809	772	1273	81.5%	84.0%	89.5%	90.2%	4011	0.5	121	4.1
10	884	1237	575	928	905	1461	82.5%	85.5%	89.5%	90.2%	3983	0.5	121	4.6
15	1186	1617	771	1213	1214	1910	82.5%	85.5%	91.0%	91.7%	7752	0.9	235	3.0
20	1400	1920	910	1440	1433	2268	84.0%	86.5%	91.7%	92.4%	9648	1.1	292	2.9
25	1740	2408	1131	1806	1781	2844	85.5%	87.5%	91.7%	92.4%	9901	1.1	300	3.5
30	2004	2705	1303	2029	2051	3195	86.5%	88.5%	92.4%	93.0%	10719	1.2	324	3.5
40	2727	3653	1773	2740	2791	4315	86.5%	88.5%	93.0%	93.6%	16094	1.8	487	3.1
50	3282	4297	2133	3223	3360	5075	88.5%	90.2%	93.0%	93.6%	13159	1.5	398	4.3
60	4659	6014	3028	4511	4769	7103	88.5%	90.2%	94.1%	94.5%	19780	2.3	599	3.9
75	5708	7345	3710	5509	5843	8675	88.5%	90.2%	94.5%	95.0%	27455	3.1	831	3.4
100	7041	9200	4577	6900	7207	10866	88.5%	90.2%	95.0%	95.4%	39490	4.5	1195	3.1
125	9095	12030	5912	9023	9310	14209	88.5%	90.2%	95.4%	95.8%	52938	6.0	1602	3.1
150	10701	13697	6956	10273	10954	16178	90.2%	91.7%	95.8%	96.2%	50004	5.7	1513	3.5
200	12597	16651	8188	12488	12895	19667	91.7%	93.0%	95.8%	96.2%	46748	5.3	1415	4.8
250	15443	20342	10038	15257	15808	24026	93.0%	93.6%	95.8%	96.2%	47174	5.4	1427	5.8
300	17726	21438	11522	16079	18145	25321	93.0%	94.1%	96.2%	96.5%	51815	5.9	1568	4.6

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST NOM EFF)-(1/EE NOM EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 24 HRS/DAY
7 DAYS/WK = 8760 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED.

SUBJECT RAAP EEAP
Electric Motors
DESIGNER T. Todd
CHECKER

AEP NO. 290 0379 000
SHEET 1 OF 9
DATE
DATE

ECO # GP-B-3 INSTALL ENERGY EFFICIENT MOTORS RATHER THAN REWIND EXISTING MOTORS

A computer spreadsheet was developed to calculate the costs, energy savings, and paybacks for motors ranging from 1 hp to 300 hp. Pages 2 & 3 show the calculations that are contained in the spreadsheet. Pages 4 through 9 are printouts of the spreadsheet on a per unit basis for hours of operation ranging from 8 hr/day, 5 days/wk to 24 hr/day, 7 days/wk.

REYNOLDS. SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT RAAP EEAP
ELECTRIC MOTOR ECO'S
DESIGNER T. TODD
CHECKER

AEP NO. 290 0379 000

DATE 5-1-90
DATE

ECO # GP-B-3

REWIND VS. REPLACE CALCULATION

ASSUMPTIONS

MOTORS ARE EXPLOSION-PROOF FOR CLASS I, GROUP D AND CLASS II, GROUPS F & G

1800 RPM, 460 VOLT, 3-PHASE

ELECTRICITY COST IS AVG OF ENERGY & DEMAND CHARGES = \$0.03026 / KWH

COSTS NO ADD'L LABOR IS INCLUDED FOR REMOVAL & INSTALLATION SINCE THIS IS THE SAME FOR BOTH REWIND AND REPLACE.

REWIND: LABOR COSTS ARE FROM ESTIMATE FROM LLOYD ELECTRIC CO., ROANOKE, VA. FOR TEFC MOTORS + 15% FOR EXPLOSION-PROOF.

MATERIAL COSTS ARE 15% OF LABOR COSTS, TO COVER BEARINGS.

$$\text{TOTAL REWIND COST} = \left[(\text{LABOR} \times 1.2) + (\text{MAT'L} \times 1.045)\right]$$

$$\times 1.15 \times 1.10 \times 1.01 \times 1.05 \times 1.06 \times 1.06$$

$$= (1.2 \times \text{LABOR} + 1.045 \times \text{MAT'L}) \times 1.507$$

REPLACE: MATERIAL COSTS ARE FROM RELIANCE ELECTRIC COMPANY LIST PRICES, WITH A CONTRACTORS DISCOUNT FACTOR OF 0.75 FOR ENERGY-EFFICIENT MOTORS.

$$\text{TOTAL REPLACEMENT COST} = (1.045 \times \text{MAT'L}) \times 1.507$$

NET COST(\$) = TOTAL REPLACEMENT COST − TOTAL REWIND COST

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SUBJECT RAAP EEAP
ELECTRIC MOTOR ECO'S
DESIGNER T. TODD
CHECKER

AEP NO 290 0379 000
SHEET 3 OF 9
DATE 5-1-90
DATE

ECO # GP-B-3

SAVINGS

$$\text{SAVINGS} = \text{MOTOR HP} \times 0.746 \frac{\text{KW}}{\text{HP}} \times \left[\frac{1}{\text{standard-duty nominal eff.}} - \frac{1}{\text{energy-efficient nominal eff.}} \right]$$

$$\times \text{ OPERATING } \frac{\text{HRS}}{\text{YR}} \times \frac{\$0.03026}{\text{KWH}}$$

$$= \$/\text{YR}$$

PAYBACK

$$\text{PAYBACK} = \frac{\text{NET COST } (\$)}{\text{SAVINGS } (\$/\text{YR})} = \text{ YRS}$$

GP-B-3 p. 4 of 9

RAAP ENERGY EFFICIENT MOTOR PROJECTS
FILENAME: RMOTRR3
DATE: 8 MAY 90

	LIST PRICE	CONTRACTOR	REWIND PRICES		MAT'L AND LABOR PRICES WITH MARKUPS		EFFICIENCIES				REPLACE VS REWIND CALCULATION			
MOTOR SIZE (HP)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	LLOYD LABOR PRICE (1990$)	BEARING PRICE (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	REWIND (1990$)	RELIANCE STD MOTOR MIN. EFF. (%)	RELIANCE STD MOTOR NOM. EFF. (%)	RELIANCE EXP-PR XE MIN EFF. (%)	RELIANCE EXP-PR XE NOM EFF. (%)	ENERGY SAVINGS (KWH/YR)	REDUCED DEMAND (KW)	COST SAVINGS ($/YR)	SIMPLE PAYBACK (YRS)
1	690	518	144	22	815	294	74.0%	77.0%	82.5%	84.0%	168	0.1	5	102.5
1.5	724	543	152	23	855	310	75.5%	78.5%	84.0%	85.5%	243	0.1	7	74.2
2	760	570	161	24	898	329	78.5%	81.5%	85.5%	86.5%	220	0.1	7	85.3
3	765	574	173	26	904	353	75.5%	78.5%	87.5%	88.5%	670	0.3	20	27.2
5	848	636	190	28	1002	388	80.0%	82.5%	87.5%	88.5%	630	0.3	19	31.8
7.5	1078	809	219	33	1273	447	81.5%	84.0%	89.5%	90.2%	952	0.5	29	28.7
10	1237	928	259	39	1461	529	82.5%	85.5%	89.5%	90.2%	946	0.5	29	32.6
15	1617	1213	322	48	1910	658	82.5%	85.5%	91.0%	91.7%	1841	0.9	56	22.5
20	1920	1440	374	56	2268	764	84.0%	86.5%	91.7%	92.4%	2291	1.1	69	21.7
25	2408	1806	431	65	2844	882	85.5%	87.5%	91.7%	92.4%	2351	1.1	71	27.6
30	2705	2029	512	77	3195	1046	86.5%	88.5%	92.4%	93.0%	2545	1.2	77	27.9
40	3653	2740	610	91	4315	1246	86.5%	88.5%	93.0%	93.6%	3821	1.8	116	26.5
50	4297	3223	736	110	5075	1505	88.5%	90.2%	93.0%	93.6%	3124	1.5	95	37.8
60	6014	4511	834	125	7103	1705	88.5%	90.2%	94.1%	94.5%	4697	2.3	142	38.0
75	7345	5509	978	147	8675	1999	88.5%	90.2%	94.5%	95.0%	6519	3.1	197	33.8
100	9200	6900	1231	185	10866	2516	88.5%	90.2%	95.0%	95.4%	9377	4.5	284	29.4
125	12030	9023	1466	220	14209	2998	88.5%	90.2%	95.4%	95.8%	12570	6.0	380	29.5
150	13697	10273	1754	263	16178	3586	90.2%	91.7%	95.8%	96.2%	11873	5.7	359	35.0
200	16651	12488	2156	323	19667	4409	91.7%	93.0%	95.8%	96.2%	11100	5.3	336	45.4
250	20342	15257	2556	383	24026	5227	93.0%	93.6%	95.8%	96.2%	11201	5.4	339	55.5
300	21438	16079	2956	443	25321	6044	93.0%	94.1%	96.2%	96.5%	12303	5.9	372	51.8

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST NOM EFF)-(1/EE NOM EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 8 HRS/DAY
5 DAYS/WK = 2080 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

GP-2-3 p. 5 of 9

RAAP ENERGY EFFICIENT MOTOR PROJECTS
FILENAME: RMOTRR3
DATE: 8 MAY 90

	LIST PRICE	CONTRACTOR	REWIND PRICES		MAT'L AND LABOR PRICES WITH MARKUPS		EFFICIENCIES				REPLACE VS REWIND CALCULATION			
MOTOR SIZE (HP)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	LLOYD LABOR PRICE (1990$)	BEARING PRICE (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	REWIND (1990$)	RELIANCE STD MOTOR MIN. EFF. (%)	RELIANCE STD MOTOR NOM. EFF. (%)	RELIANCE EXP-PR XE MIN EFF. (%)	RELIANCE EXP-PR XE NOM EFF. (%)	ENERGY SAVINGS (KWH/YR)	REDUCED DEMAND (KW)	COST SAVINGS ($/YR)	SIMPLE PAYBACK (YRS)
1	690	518	144	22	815	294	74.0%	77.0%	82.5%	84.0%	236	0.1	7	73.0
1.5	724	543	152	23	855	310	75.5%	78.5%	84.0%	85.5%	341	0.1	10	52.8
2	760	570	161	24	898	329	78.5%	81.5%	85.5%	86.5%	309	0.1	9	60.8
3	765	574	173	26	904	353	75.5%	78.5%	87.5%	88.5%	941	0.3	28	19.4
5	848	636	190	28	1002	388	80.0%	82.5%	87.5%	88.5%	895	0.3	27	22.7
7.5	1078	809	219	33	1273	447	81.5%	84.0%	89.5%	90.2%	1337	0.5	40	20.4
10	1237	928	259	39	1461	529	82.5%	85.5%	89.5%	90.2%	1328	0.5	40	23.2
15	1617	1213	322	48	1910	658	82.5%	85.5%	91.0%	91.7%	2584	0.9	78	16.0
20	1920	1440	374	56	2268	764	84.0%	86.5%	91.7%	92.4%	3216	1.1	97	15.5
25	2408	1806	431	65	2844	882	85.5%	87.5%	91.7%	92.4%	3300	1.1	100	19.6
30	2705	2029	512	77	3195	1046	86.5%	88.5%	92.4%	93.0%	3573	1.2	108	19.9
40	3653	2740	610	91	4315	1246	86.5%	88.5%	93.0%	93.6%	5365	1.8	162	18.9
50	4297	3223	736	110	5075	1505	88.5%	90.2%	93.0%	93.6%	4386	1.5	133	26.9
60	6014	4511	834	125	7103	1705	88.5%	90.2%	94.1%	94.5%	6593	2.3	200	27.1
75	7345	5509	978	147	8675	1999	88.5%	90.2%	94.5%	95.0%	9152	3.1	277	24.1
100	9200	6900	1231	185	10866	2516	88.5%	90.2%	95.0%	95.4%	13163	4.5	398	21.0
125	12030	9023	1466	220	14209	2998	88.5%	90.2%	95.4%	95.8%	17646	6.0	534	21.0
150	13697	10273	1754	263	16178	3586	90.2%	91.7%	95.8%	96.2%	16668	5.7	504	25.0
200	16651	12488	2156	323	19667	4409	91.7%	93.0%	95.8%	96.2%	15583	5.3	472	32.4
250	20342	15257	2556	383	24026	5227	93.0%	93.6%	95.8%	96.2%	15725	5.4	476	39.5
300	21438	16079	2956	443	25321	6044	93.0%	94.1%	96.2%	96.5%	17272	5.9	523	36.9

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST NOM EFF)-(1/EE NOM EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 8 HRS/DAY
7 DAYS/WK = 2920 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

RAAP ENERGY EFFICIENT MOTOR PROJECTS
FILENAME: RMOTRR3
DATE: 8 MAY 90

MOTOR SIZE (HP)	LIST PRICE: RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	CONTRACTOR: RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	REWIND PRICES: LLOYD LABOR PRICE (1990$)	REWIND PRICES: BEARING PRICE (1990$)	MAT'L AND LABOR PRICES WITH MARKUPS: RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	MAT'L AND LABOR PRICES WITH MARKUPS: REWIND (1990$)	EFFICIENCIES: RELIANCE STD MOTOR MIN. EFF. (%)	EFFICIENCIES: RELIANCE STD MOTOR NOM. EFF. (%)	EFFICIENCIES: RELIANCE EXP-PR XE MIN EFF. (%)	EFFICIENCIES: RELIANCE EXP-PR XE NOM EFF. (%)	REPLACE VS REWIND CALCULATION: ENERGY SAVINGS (KWH/YR)	REPLACE VS REWIND CALCULATION: REDUCED DEMAND (KW)	REPLACE VS REWIND CALCULATION: COST SAVINGS ($/YR)	REPLACE VS REWIND CALCULATION: SIMPLE PAYBACK (YRS)
1	690	518	144	22	815	294	74.0%	77.0%	82.5%	84.0%	336	0.1	10	51.3
1.5	724	543	152	23	855	310	75.5%	78.5%	84.0%	85.5%	485	0.1	15	37.1
2	760	570	161	24	898	329	78.5%	81.5%	85.5%	86.5%	440	0.1	13	42.7
3	765	574	173	26	904	353	75.5%	78.5%	87.5%	88.5%	1340	0.3	41	13.6
5	848	636	190	28	1002	388	80.0%	82.5%	87.5%	88.5%	1275	0.3	39	15.9
7.5	1078	809	219	33	1273	447	81.5%	84.0%	89.5%	90.2%	1905	0.5	58	14.3
10	1237	928	259	39	1461	529	82.5%	85.5%	89.5%	90.2%	1891	0.5	57	16.3
15	1617	1213	322	48	1910	658	82.5%	85.5%	91.0%	91.7%	3681	0.9	111	11.2
20	1920	1440	374	56	2268	764	84.0%	86.5%	91.7%	92.4%	4582	1.1	139	10.8
25	2408	1806	431	65	2844	882	85.5%	87.5%	91.7%	92.4%	4702	1.1	142	13.8
30	2705	2029	512	77	3195	1046	86.5%	88.5%	92.4%	93.0%	5090	1.2	154	13.9
40	3653	2740	610	91	4315	1246	86.5%	88.5%	93.0%	93.6%	7643	1.8	231	13.3
50	4297	3223	736	110	5075	1505	88.5%	90.2%	93.0%	93.6%	6249	1.5	189	18.9
60	6014	4511	834	125	7103	1705	88.5%	90.2%	94.1%	94.5%	9393	2.3	284	19.0
75	7345	5509	978	147	8675	1999	88.5%	90.2%	94.5%	95.0%	13038	3.1	395	16.9
100	9200	6900	1231	185	10866	2516	88.5%	90.2%	95.0%	95.4%	18753	4.5	567	14.7
125	12030	9023	1466	220	14209	2998	88.5%	90.2%	95.4%	95.8%	25140	6.0	761	14.7
150	13697	10273	1754	263	16178	3506	90.2%	91.7%	95.8%	96.2%	23746	5.7	719	17.5
200	16651	12488	2156	323	19667	4409	91.7%	93.0%	95.8%	96.2%	22200	5.3	672	22.7
250	20342	15257	2556	383	24026	5227	93.0%	93.6%	95.8%	96.2%	22402	5.4	678	27.7
300	21438	16079	2956	443	25321	6044	93.0%	94.1%	96.2%	96.5%	24606	5.9	745	25.9

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT

MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE

SAVINGS = HP * 0.746*[(1/ST NOM EFF)-(1/EE NOM EFF)] * HRS/YR * ELECOST

OPERATING TIMES: 16 HRS/DAY
5 DAYS/WK = 4160 HRS/YR

ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

RAAP ENERGY EFFICIENT MOTOR PROJECTS
FILENAME: RMOTRR3
DATE: 8 MAY 90

MOTOR SIZE (HP)	LIST PRICE: RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	CONTRACTOR: RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	REWIND PRICES: LLOYD LABOR PRICE (1990$)	REWIND PRICES: BEARING PRICE (1990$)	MAT'L AND LABOR PRICES WITH MARKUPS: RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	MAT'L AND LABOR PRICES WITH MARKUPS: REWIND (1990$)	EFFICIENCIES: RELIANCE STD MOTOR MIN. EFF. (%)	EFFICIENCIES: RELIANCE STD MOTOR NOM. EFF. (%)	EFFICIENCIES: RELIANCE EXP-PR XE MIN EFF. (%)	EFFICIENCIES: RELIANCE EXP-PR XE NOM EFF. (%)	REPLACE VS REWIND CALCULATION: ENERGY SAVINGS (KWH/YR)	REPLACE VS REWIND CALCULATION: REDUCED DEMAND (KW)	REPLACE VS REWIND CALCULATION: COST SAVINGS ($/YR)	REPLACE VS REWIND CALCULATION: SIMPLE PAYBACK (YRS)
1	690	518	144	22	815	294	74.0%	77.0%	82.5%	84.0%	471	0.1	14	36.5
1.5	724	543	152	23	855	310	75.5%	78.5%	84.0%	85.5%	682	0.1	21	26.4
2	760	570	161	24	898	329	78.5%	81.5%	85.5%	86.5%	618	0.1	19	30.4
3	765	574	173	26	904	353	75.5%	78.5%	87.5%	88.5%	1081	0.3	57	9.7
5	848	636	190	28	1002	388	80.0%	82.5%	87.5%	88.5%	1790	0.3	54	11.3
7.5	1078	809	219	33	1273	447	81.5%	84.0%	89.5%	90.2%	2674	0.5	81	10.2
10	1237	928	259	39	1461	529	82.5%	85.5%	89.5%	90.2%	2655	0.5	80	11.6
15	1617	1213	322	48	1910	658	82.5%	85.5%	91.0%	91.7%	5168	0.9	156	8.0
20	1920	1440	374	56	2268	764	84.0%	86.5%	91.7%	92.4%	6432	1.1	195	7.7
25	2408	1806	431	65	2844	882	85.5%	87.5%	91.7%	92.4%	6601	1.1	200	9.8
30	2705	2029	512	77	3195	1046	86.5%	88.5%	92.4%	93.0%	7146	1.2	216	9.9
40	3653	2740	610	91	4315	1246	86.5%	88.5%	93.0%	93.6%	10729	1.8	325	9.5
50	4297	3223	736	110	5075	1505	88.5%	90.2%	93.0%	93.6%	8772	1.5	265	13.5
60	6014	4511	834	125	7103	1705	88.5%	90.2%	94.1%	94.5%	13187	2.3	399	13.5
75	7345	5509	978	147	8675	1999	88.5%	90.2%	94.5%	95.0%	18303	3.1	554	12.1
100	9200	6900	1231	185	10866	2516	88.5%	90.2%	95.0%	95.4%	26327	4.5	797	10.5
125	12030	9023	1466	220	14209	2998	88.5%	90.2%	95.4%	95.8%	35292	6.0	1068	10.5
150	13697	10273	1754	263	16178	3586	90.2%	91.7%	95.8%	96.2%	33336	5.7	1009	12.5
200	16651	12488	2156	323	19667	4409	91.7%	93.0%	95.8%	96.2%	31165	5.3	943	16.2
250	20342	15257	2556	383	24026	5227	93.0%	93.6%	95.8%	96.2%	31450	5.4	952	19.8
300	21438	16079	2956	443	25321	6044	93.0%	94.1%	96.2%	96.5%	34544	5.9	1045	18.4

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST NOM EFF)-(1/EE NOM EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 16 HRS/DAY
7 DAYS/WK = 5840 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

RAAP ENERGY EFFICIENT MOTOR PROJECTS
FILENAME: RMOTRR3
DATE: 8 MAY 90

	LIST PRICE	CONTRACTOR	REWIND PRICES		MAT'L AND LABOR PRICES WITH MARKUPS		EFFICIENCIES				REPLACE VS REWIND CALCULATION			
MOTOR SIZE (HP)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	LLOYD LABOR PRICE (1990$)	BEARING PRICE (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	REWIND (1990$)	RELIANCE STD MOTOR MIN. EFF. (%)	RELIANCE STD MOTOR NOM. EFF. (%)	RELIANCE EXP-PR XE MIN EFF. (%)	RELIANCE EXP-PR XE NOM EFF. (%)	ENERGY SAVINGS (KWH/YR)	REDUCED DEMAND (KW)	COST SAVINGS ($/YR)	SIMPLE PAYBACK (YRS)
1	690	518	144	22	815	294	74.0%	77.0%	82.5%	84.0%	504	0.1	15	34.2
1.5	724	543	152	23	855	310	75.5%	78.5%	84.0%	85.5%	728	0.1	22	24.7
2	760	570	161	24	898	329	78.5%	81.5%	85.5%	86.5%	660	0.1	20	28.4
3	765	574	173	26	904	353	75.5%	78.5%	87.5%	88.5%	2010	0.3	61	9.1
5	848	636	190	28	1002	388	80.0%	82.5%	87.5%	88.5%	1913	0.3	58	10.6
7.5	1078	809	219	33	1273	447	81.5%	84.0%	89.5%	90.2%	2857	0.5	86	9.6
10	1237	928	259	39	1461	529	82.5%	85.5%	89.5%	90.2%	2837	0.5	86	10.9
15	1617	1213	322	48	1910	658	82.5%	85.5%	91.0%	91.7%	5522	0.9	167	7.5
20	1920	1440	374	56	2268	764	84.0%	86.5%	91.7%	92.4%	6873	1.1	208	7.2
25	2408	1806	431	65	2844	882	85.5%	87.5%	91.7%	92.4%	7053	1.1	213	9.2
30	2705	2029	512	77	3195	1046	86.5%	88.5%	92.4%	93.0%	7635	1.2	231	9.3
40	3653	2740	610	91	4315	1246	86.5%	88.5%	93.0%	93.6%	11464	1.8	347	8.8
50	4297	3223	736	110	5075	1505	88.5%	90.2%	93.0%	93.6%	9373	1.5	284	12.6
60	6014	4511	834	125	7103	1705	88.5%	90.2%	94.1%	94.5%	14090	2.3	426	12.7
75	7345	5509	978	147	8675	1999	88.5%	90.2%	94.5%	95.0%	19557	3.1	592	11.3
100	9200	6900	1231	185	10866	2516	88.5%	90.2%	95.0%	95.4%	28130	4.5	851	9.8
125	12030	9023	1466	220	14209	2998	88.5%	90.2%	95.4%	95.8%	37709	6.0	1141	9.8
150	13697	10273	1754	263	16178	3586	90.2%	91.7%	95.8%	96.2%	35619	5.7	1078	11.7
200	16651	12488	2156	323	19667	4409	91.7%	93.0%	95.8%	96.2%	33300	5.3	1008	15.1
250	20342	15257	2556	383	24026	5227	93.0%	93.6%	95.8%	96.2%	33604	5.4	1017	18.5
300	21438	16079	2956	443	25321	6044	93.0%	94.1%	96.2%	96.5%	36910	5.9	1117	17.3

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST NOM EFF)-(1/EE NOM EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 24 HRS/DAY
5 DAYS/WK = 6240 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

GD E... p. 3 of 3

RAAP ENERGY EFFICIENT MOTOR PROJECTS
FILENAME: RMOTRR3
DATE: 8 MAY 90

	LIST PRICE	CONTRACTOR	REWIND PRICES		MAT'L AND LABOR PRICES WITH MARKUPS		EFFICIENCIES				REPLACE VS REWIND CALCULATION			
MOTOR SIZE (HP)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	LLOYD LABOR PRICE (1990$)	BEARING PRICE (1990$)	RELIANCE ENERGY-EFF. EXP-PROOF (1990$)	REWIND (1990$)	RELIANCE STD MOTOR MIN. EFF. (%)	RELIANCE STD MOTOR NOM. EFF. (%)	RELIANCE EXP-PR XE MIN EFF. (%)	RELIANCE EXP-PR XE NOM EFF. (%)	ENERGY SAVINGS (KWH/YR)	REDUCED DEMAND (KW)	COST SAVINGS ($/YR)	SIMPLE PAYBACK (YRS)
1	690	518	144	22	815	294	74.0%	77.0%	82.5%	84.0%	707	0.1	21	24.3
1.5	724	543	152	23	855	310	75.5%	78.5%	84.0%	85.5%	1022	0.1	31	17.6
2	760	570	161	24	898	329	78.5%	81.5%	85.5%	86.5%	927	0.1	28	20.3
3	765	574	173	26	904	353	75.5%	78.5%	87.5%	88.5%	2822	0.3	85	6.5
5	848	636	190	28	1002	388	80.0%	82.5%	87.5%	88.5%	2685	0.3	81	7.6
7.5	1078	809	219	33	1273	447	81.5%	84.0%	89.5%	90.2%	4011	0.5	121	6.8
10	1237	928	259	39	1461	529	82.5%	85.5%	89.5%	90.2%	3983	0.5	121	7.7
15	1617	1213	322	48	1910	658	82.5%	85.5%	91.0%	91.7%	7752	0.9	235	5.3
20	1920	1440	374	56	2268	764	84.0%	86.5%	91.7%	92.4%	9648	1.1	292	5.2
25	2408	1806	431	65	2844	882	85.5%	87.5%	91.7%	92.4%	9901	1.1	300	6.5
30	2705	2029	512	77	3195	1046	86.5%	88.5%	92.4%	93.0%	10719	1.2	324	6.6
40	3653	2740	610	91	4315	1246	86.5%	88.5%	93.0%	93.6%	16094	1.8	487	6.3
50	4297	3223	736	110	5075	1505	88.5%	90.2%	93.0%	93.6%	13159	1.5	398	9.0
60	6014	4511	834	125	7103	1705	88.5%	90.2%	94.1%	94.5%	19780	2.3	599	9.0
75	7345	5509	978	147	8675	1999	88.5%	90.2%	94.5%	95.0%	27455	3.1	831	8.0
100	9200	6900	1231	185	10866	2516	88.5%	90.2%	95.0%	95.4%	39490	4.5	1195	7.0
125	12030	9023	1466	220	14209	2998	88.5%	90.2%	95.4%	95.8%	52938	6.0	1602	7.0
150	13697	10273	1754	263	16178	3586	90.2%	91.7%	95.8%	96.2%	50004	5.7	1513	8.3
200	16651	12488	2156	323	19667	4409	91.7%	93.0%	95.8%	96.2%	46748	5.3	1415	10.8
250	20342	15257	2556	383	24026	5227	93.0%	93.6%	95.8%	96.2%	47174	5.4	1427	13.2
300	21438	16079	2956	443	25321	6044	93.0%	94.1%	96.2%	96.5%	51815	5.9	1568	12.3

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE EXPLOSION-PROOF, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST NOM EFF)-(1/EE NOM EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 24 HRS/DAY
7 DAYS/WK = 8760 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0303 /KWH

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT

DESIGNER PEH

CHECKER

AEP NO.

SHEET / OF

DATE 5/31/90

DATE

ECO # GP-B-4

Install variable frequency drives in main plant water supply pumps

1. Calculate current energy use

Current practice is to operate 1-600 hp turbine pump plus 1-100 hp deep well and 1-400 hp booster pump in combination. The current average flow rate is 24 million gal/da. Average usage is about 12 million gal/da

Turbine pump:

$$kW_T = \text{volts} \cdot \text{amps} \cdot \sqrt{3} / 1000$$

$$= 2300 \cdot 127 \cdot \sqrt{3} / 1000 = 506\ kW$$

Deep well pump:

$$kW_D = 2300 \cdot 23 \cdot \sqrt{3} / 1000 = 92\ kW$$

Booster pump

$$kW_B = 2200 \cdot 130 \cdot \sqrt{3} / 1000 = 495\ kW$$

$$\text{Total } kW = 506 + 92 + 495 = 1093\ kW$$

Average annual usage = 1093 · 3760 = 9,574,680 kWh

Average annual cost = 9,574,680 × 0.03 = $287,240

Annual usage (MBtu) = 9,574,680 × 3413 = 32,678 MBtu

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT ....
DESIGNER ....
CHECKER ....

AEP NO ....
SHEET .... OF ....
DATE ....
DATE ....

2. Calculate energy savings

Calculate system head for following current conditions

$$e h_p = 1093 \text{ kW}$$
$$\eta_p = 0.70$$
$$\eta_m = 0.95$$
$$Q = 24{,}000{,}000 \text{ gal/da} = 16{,}667 \text{ gpm}$$

$ehp = bhp / \eta_m$ $\qquad$ $kW = 0.75 * ehp$

$bhp = whp / \eta_p$ $\qquad$ $ehp = kW / 0.75$

$$ehp = whp / \eta_m / \eta_p$$

$$whp = \frac{H \cdot Q}{3960}$$

$$ehp = \frac{H \cdot Q}{3960 \cdot \eta_p \cdot \eta_m} = \frac{kW}{0.75}$$

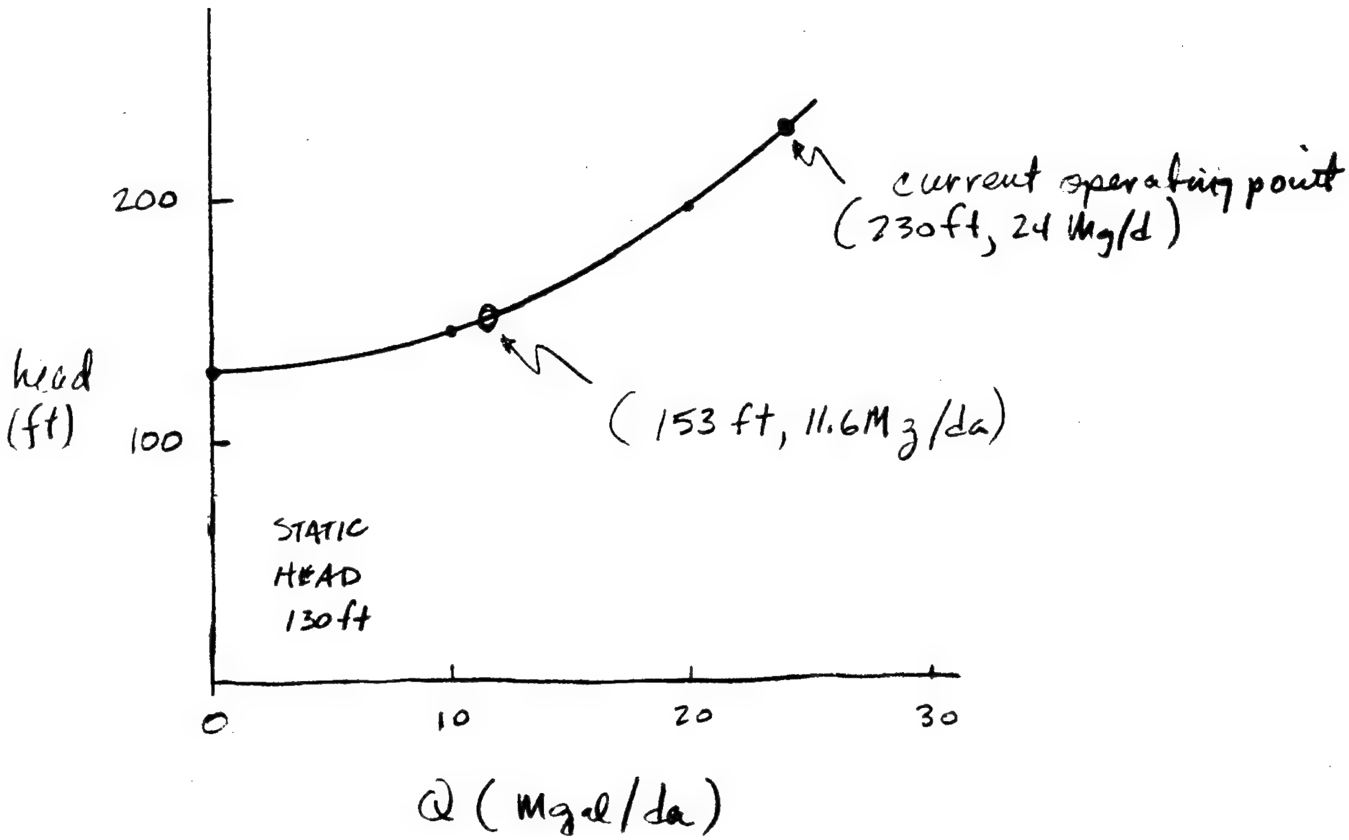
$$H = \frac{kW \cdot 3960 \cdot \eta_p \cdot \eta_m}{Q \cdot 0.75}$$

$$H = \frac{1093 \cdot 3960 \cdot 0.70 \cdot 0.95}{16{,}667 \cdot 0.75}$$

$$H = 230 \text{ feet}$$

Assume static head is about 150 feet.

Water Plant System Curve



$$\text{savings} = \text{current use} - \text{current} \times \frac{\text{new head}}{\text{old head}}$$

$$= \text{current use} \left(1 - \frac{H_n}{H_o}\right)$$

$$= 32{,}678 \text{ MBtu} \left(1 - \frac{153}{230}\right) =$$

$$= \underline{10{,}940} \text{ MBtu (electricity)}$$

Telephone Call Confirmation

reynolds, smith and hills

Project No. 290-0379-000
(904) 281-0394

Local ✓ L.D. ______ Placed ✓ Rec'd ______ Date 5/29/90

P. Hutchins Conversed with Mark Riffle

Of Westinghouse Elec. Corp. Regarding Variable Frequency Drives

MR gave budget estimates for variable speed drives

	labor	materials
600 hp	$2000	$60,000
450 hp	$2000	$40,000
100 hp	$2000	$12,000

Distribution:

CONSTRUCTION COST ESTIMATE

DATE PREPARED

SHEET OF

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: RADFORD ARMY AMMUNITION PLANT

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE

- ☐ CODE A (No design completed)
- ☐ CODE B (Preliminary design)
- ☐ CODE C (Final design)
- ☐ OTHER (Specify)

DRAWING NO.: ECO# GP-B-4

ESTIMATOR: P. Hutchins

CHECKED BY

VARIABLE SPEED DRIVES SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
1-600 hp VSD	1	ea		2000		60,000	62,000
1-400 hp VSD	1	ea		2,000		40,000	42,000
1-100 hp VSD	1	ea		2000		12,000	14,000
Subtotal				6000		112,000	118,000
Sales Tax (4.5%)						5040	5040
FICA/Ins. (20%)				1200			1200
Subtotal				7200		117,040	124,240
Overhead (15%)							18,636
Profit (10%)							14,288
Bond (1%)							1572
Hercules Support (6%)							9524
Contingency (10%)							16826
Construction Cost							$185,086

Vendor quote Westinghouse

ECO # GP-D-1

INERT GAS SYSTEM Replacement

SAVINGS FROM CAPTURING HEAT & GENERATING STEAM

(40 psig)

PERMEA ESTIMATES 1800 LBS STEAM/HR from 60,000 CFH UNIT. Steam savings are:

$$\frac{1800 \text{ LBS/HR} \times 1175.9 \text{ BTU/LB} \times 8760}{10^6} = \boxed{18{,}542 \text{ Mbtu/yr.}}$$

Coal savings: $18{,}542 \frac{\text{MBtu}_s}{\text{Yr}} \times 1.32 \frac{\text{MBtu}_c}{\text{MBtu}_s} = 24{,}475 \text{ MBtu/yr}$

$24{,}475 \frac{\text{MBtu}}{\text{Yr}} \times 1.61 \text{ \$/MBtu} = \$39{,}405/\text{Yr}$

Electricity Purchase Penalty:

$18{,}542 * 0.111 * 8.87 = \$18{,}256/\text{yr.}$

Reduced Power House O&M:

$18{,}542 \frac{\text{MBtu}_s}{\text{Yr}} \times \$1.01/\text{MBtu}_s = \$18{,}727/\text{Yr}$

Non Energy Savings = $\$18{,}727 - 18{,}256 = \$471/\text{yr}$

CONSTRUCTION COST ESTIMATE	DATE PREPARED 5-23-90	SHEET 1 OF

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: RADFORD ARMY AMMUNITION PLANT

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE
- [ ] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.

ESTIMATOR: G. FALLON

CHECKED BY: GA

SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
INERT GAS GEN./BOILER	1	ea	$2400	2400	177,000	177,000	180,000
TAX 4.5%						7,965	7,965
FICA/INSURANCE 20%				600			600
							188,565
SUB TOTAL							
OVERHEAD 15%							28,284
SUB TOTAL							216,850
PROFIT 10%							21,685
SUB TOTAL							238,535
BOND 1%							2385
SUB TOTAL							240920
CONTINGENCY 7.5%							18,069
SUB TOTAL							258,989
Hercules 6.0%							15,539
SUB TOTAL							274,528

ENG FORM 150 1 AUG 59 (ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

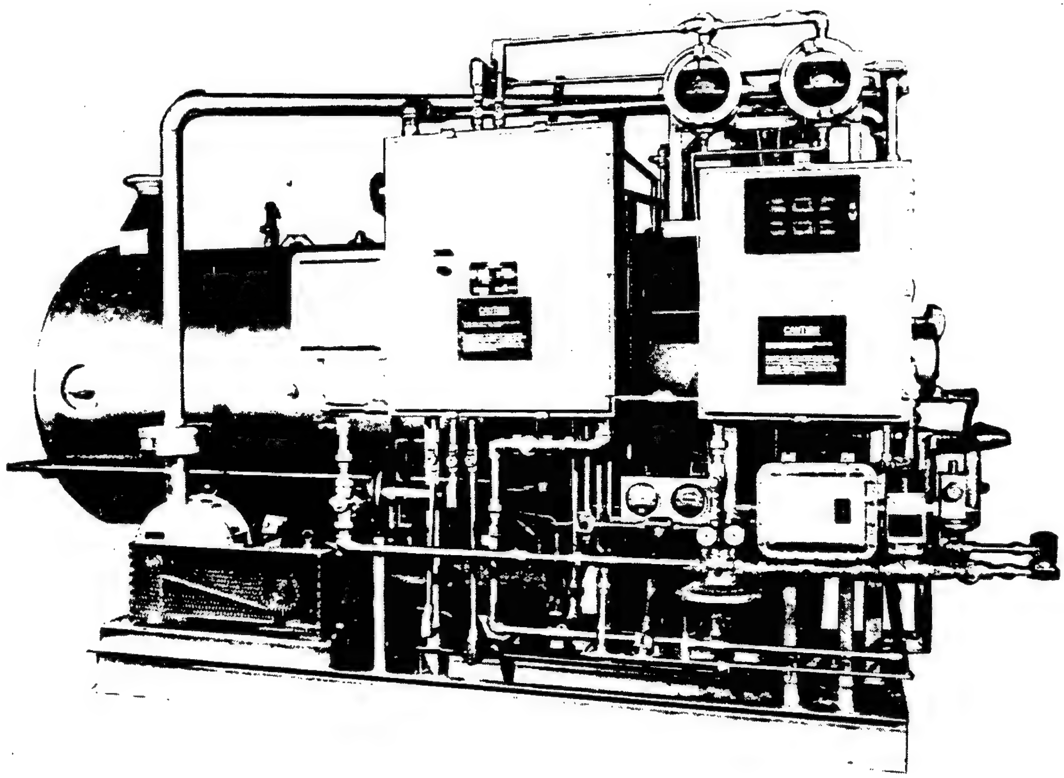
* U.S. GOVERNMENT PRINTING OFFICE

Count on KEMP for

COGENERATION

Kemp ERG—the energy recovery generator for plant processes requiring inert gas and steam or nitrogen and steam.

This ERG qualifies for a 10% tax credit if applied to P.L. #96-223 for waste heat recovery.



For Inert/Nitrogen Generation

The Kemp ERG System will produce inert or nitrogen gas. It is the result of Kemp's unique handcrafted nozzle mix burner system that promotes the complete reaction of air and fuel.

For Steam Generation

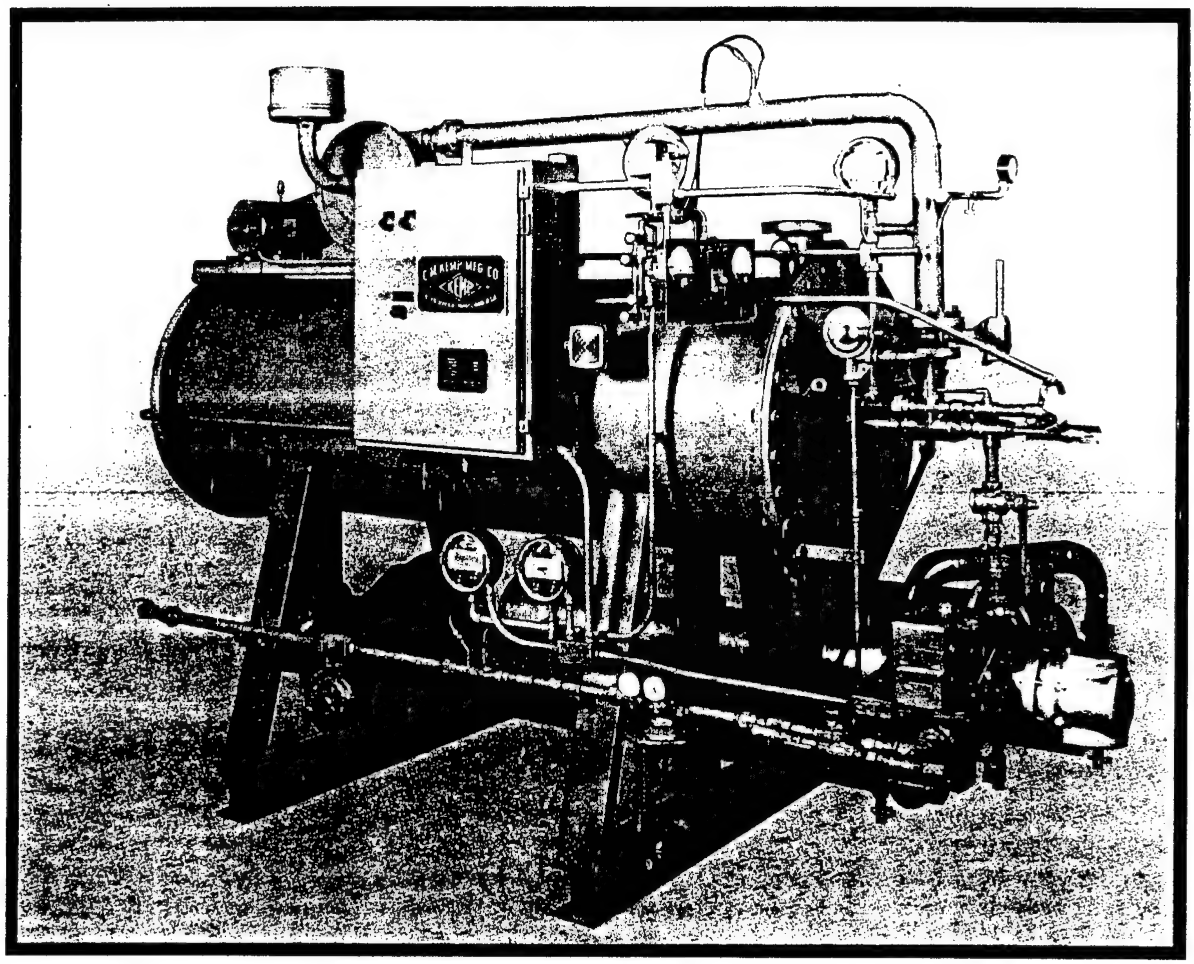
The Kemp ERG offers "two for one" use of your fuel! The boiler is sized with your inert gas requirements in mind but has an efficiency rating of over 80%. The residual steam is rated at 150 PSIG or can be provided in other pressures on request. Such high efficiency provides great advantages over conventional systems:

- Accelerated payback—half the normal capital equipment time span.
- Lower water requirements—75% less than a standard generator.
- Percentage tax depreciation and waste heat credit.

KEMP®

KEMP®

PH Series
Inert Gas Generators



- Low Cost Inert Gas
- High Purity
- Simplified Installation
- Indirect Cooling

HUNTER

Telephone Call Confirmation

Project No. 290-0379-000

Local ______ L.D. X Placed X Rec'd. ______ Date 5-22-90

Conversed With DALE JACKS

Of PERMEA INC. Regarding INERT GAS GEN.
(713) 684-0438

NEW

60,000 ACFH IGG WILL PRODUCE 1800 LBS STEAM/HR
COST ≈ $200,000 INSTALLED.
$177,000 DELIVERED
20,000 ACFH ≈ $100,000 ~~INSTALLED~~ DELIVERED
FLOW ≈ 600 PPH.

Distribution:

RS&H®

TEMPERATURE

DESIGNER G. FALLON

CHECKER

SHEET 1 OF 1

DATE 10-19-90

DATE

GP-D-2 REDUCE STACK TEMPERATURE

REFER TO CHX DATA ATTACHED. (MEDIUM CASE)

TOTAL ENERGY RECOVERED (SAVED)

26.8 MBTU/HR x 8030 H/yr. = 215,204 MBTU/yr.

TOTAL COAL COST SAVED

215,204 MBTU/yr x $1.61/MBTU = $346,478 /yr.

ADDITIONAL ELECTRICITY REQUIRED

34 HP x .746 x 8030 = 203673 Kwh

203673 kwh x $0.03026/kwh = 6163

NET SAVINGS

$346,478/yr − $6163/yr = $340315/yr. ⇒ $340,000

COMPANY	HERCULES - RAAP
LOCATION	RADFORD, VA
HRS PROPOSAL NO.	820-02
REPRESENTATIVE	JCJ
PROPOSAL STATUS	PRELIMINARY
PPOPOSAL DATE	AUGUST 20, 1990
APPLICATION	HEAT BOILER MAKEUP WATER
BOILER NAMEPLATE RATING	510,000 LBS/HOUR

MEDIUM

24,000,000 LBS NC PER YEAR

CASE 1 OF 5

HRS SYSTEM MODEL # 3-416-160 DW 7

[redacted] PERFORMANCE @ 225,000 PPH STEAM LOAD

DESIGN PARAMETERS

AVERAGE STEAMLOAD FOR CASE	225,000	LBS/HOUR
AVAILABLE FLUE GAS MASS	331,239	LBS/HOUR
BOILER FEEDWATER TEMPERATURE	268.0	DEGREES F.
STEAM PRESSURE (750 DEG. F)	400	PSIG
EXCESS COMBUSTION AIR	30.00	PERCENT
FLUE GAS TEMP @ SOURCE	350.0	DEGREES F.
MAXIMUM WATERFLOW AVAILABLE TO HX	718	GAL/MIN
FLUE GAS WATER VAPOR DEWPOINT	102.6	DEGREES F.
FLUE GAS DENSITY	0.0523	LBS/CU.FT.
SPECIFIC HEAT OF FLUE GAS	0.2504	BTU/LB DEG. F.
HOURS OF OPERATION FOR CASE	2920	HOURS/YEAR
FUEL FIRED		COAL
FUEL COST	$1.60	DOLLARS/MM BTU
EXISTING FUEL TO STEAM EFFICIENCY	85.74	PERCENT
EXISTING THERMAL EFFICIENCY	87.32	PERCENT

HEAT EXCHANGER PERFORMANCE

FLUE GAS MASS FLOW @ HX INLET	331,239	LBS/HOUR
FLUE GAS FLOW @ INLET TO HX	105,472	ACFM
FLUE GAS INLET TEMP	350.0	DEGREES F.
FLUE GAS OUTLET TEMPERATURE	102.3	DEGREES F.
WATERFLOW THROUGH HX	405.0	GAL/MIN
WATER INLET TEMPERATURE	55.0	DEGREES F.
WATER OUTLET TEMPERATURE	187.6	DEGREES F.
SENSIBLE HEAT RECOVERED	20,545,662	BTUS/HOUR
LATENT HEAT RECOVERED	6,251,306	BTUS/HOUR
TOTAL HEAT RECOVERY	[redacted]	
SAVINGS FOR THIS CASE	[redacted]	

ENGINEERING DATA

NEW BOILER FUEL TO STEAM EFFICIENCY	94.60	PERCENT
NEW THERMAL EFFICIENCY	[redacted]	
EFFICIENCY INCREASE	[redacted]	
FUEL SAVINGS	10.33	PERCENT
WATERSIDE PRESSURE DROP	2.97	PSIG.
THEORETICAL FAN POWER	[redacted]	
HEAT EXCHANGER FLUE GAS PRESSURE DROP	0.51	IN. W.C.
PLENUM, DUCT AND BREECHING LOSS	0.25	IN. W.C.
CONDENSATE FLOW RATE	12.2	GAL/MIN

COAL ANALYSIS USED FOR THIS CASE

%C	%H2	%N2	%O2	%S	%H2O	%ASH	HHV
75.00	5.00	1.50	6.70	2.30	2.50	7.00	13000

CHX
Condensing Heat Exchanger Corp.
Route 7, Drawer H • Warnerville, N.Y. 12187 • (518) 234-2541

August 20, 1990

Mr. Steven L. DeBusk
Industrial Engineer
Hercules - RAAP
P.O. Box 1
Radford, VA 24141

Dear Steve,

The enclosed performance printouts are divided into 3 groups; low, medium and high, to represent possible production requirements, with 5 cases in each group to represent firing levels at different times of the year or times of the day. Because the CHX Condensing Economizer is normally installed as a slip stream device and therefore can be sized for the heat duty rather than the nameplate capacity of the boilers, the heat exchanger size for the "low" scenario is smaller than the model we originally discussed and the size for "medium and high" is larger than the original.

The preliminary size choice for the "low" condition is a CHX Model 2-416-120 DW7 which would generate net energy savings of about $306,000 per year. The current budget equipment cost estimate for this size is $725,000. The "medium and high" condition would require a CHX Model 3-416-160 DW7. The current budget equipment cost estimate for this size is $1,250,000. The "medium" condition would generate net energy savings of $531,000. The "high" condition net savings would be $596,000.

If particulate emission reduction is a major factor in the evaluation of this energy recovery project, the equipment configuration and subsiquent performance can be optimized to generate more condensate flow which will improve removal efficiency. This would probably increase the pay-back period. Another method to enhance removal efficiency is to spray additional water into the heat exchanger. This would reduce energy recovery slightly.

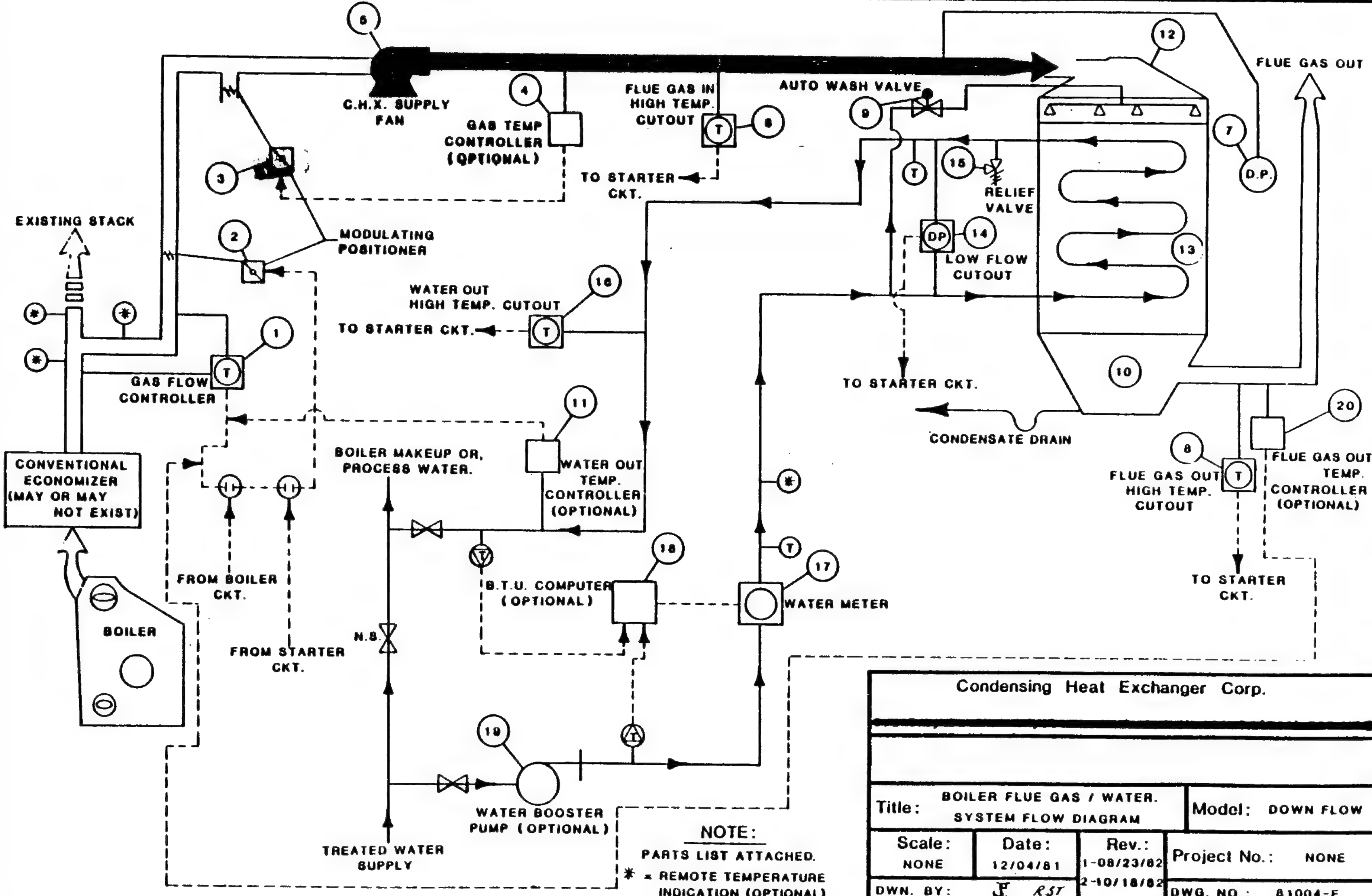
I will call you next week to further discuss this possible energy recovery/particulate removal project.

Very truly yours,

John

(515) 798 - 9637

John C. Joseph
Dir Applications Engineering



NOTE:

PARTS LIST ATTACHED.

✱ = REMOTE TEMPERATURE INDICATION (OPTIONAL)

Condensing Heat Exchanger Corp.

Title: BOILER FLUE GAS / WATER. SYSTEM FLOW DIAGRAM				Model: DOWN FLOW
Scale: NONE	Date: 12/04/81	Rev.: 1-08/23/82 2-10/18/82		Project No.: NONE
DWN. BY: RST				DWG. NO.: 81004-F
ENG. APPR. BY:				OF: 1

CONSTRUCTION COST ESTIMATE	DATE PREPARED	SHEET OF

PROJECT
ENERGY ENGINEERING ANALYSIS

LOCATION
RADFORD AAP, RADFORD, VA.

ARCHITECT ENGINEER
REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE
☐ CODE A (No design completed)
☐ CODE B (Preliminary design)
☐ CODE C (Final design)
☐ OTHER (Specify)

DRAWING NO.	ESTIMATOR GWF	CHECKED BY RH

CONDENSING HEAT EXCHANGER SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HEAT EXCHANGER				725,000		725,000	$1,450,000

THIS AMOUNT INCLUDES ALL MARK-UPS SINCE IT IS NOT RECOMMENDED NO FURTHER BREAKDOWN IS INCLUDED.

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT RAAP Lighting Projects
AEP NO. 290 0379 000
SHEET 1 OF 10
DESIGNER T. Todd
DATE
CHECKER
DATE

GP-N-1 REPLACE INCANDESCENTS WITH 35 W HPS SCREW-INS FOR EXPLOSION-PROOF FIXTURES

Calculations were made on a per-unit basis for installing 35 W HPS "units" within the existing explosion-proof incandescent fixtures. These units consist of a HPS lamp and a ballast with a medium base adapter which screws into the incandescent socket. The per-unit calculations are on page 2.

From the building survey data, a list was compiled of the buildings with potential incandescent lighting projects (page 3). Only areas with lighting operating 3 shifts/day, 5 days/wk were considered. It is assumed that 90% of the interior and 50% of the exterior fixtures can be retrofitted in the manner described above for this ECO.

Total fixtures = 0.9(1536) + 0.5(717) = 1740

Energy savings = 674 kwh/yr × 0.003413 MBtu/kwh × 1740 fixtures = 4003 MBtu/yr

Energy cost savings = $\frac{\$20.39}{\text{yr-fixture}}$ × 1740 fixtures = \$35,479/yr

Labor & mat'l cost savings = $\frac{\$17.44}{\text{yr-fixture}}$ × 1740 = \$30,346/yr

Total cost savings = \$35479 + \$30346 = \$65,825/yr

Project cost = $\frac{\$80.46}{\text{fixture}}$ × 1740 fixtures = \$140,000

(Construction cost = \$140,000/1.115 = \$125,561)

Simple payback = $\frac{\$140,000}{\$65,825/\text{yr}}$ = 2.1 yr

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT RAAP Lighting Projects Screening Calcs.
DESIGNER T. Todd
CHECKER

AEP NO 290 0379 000
SHEET 2 OF 10
DATE
DATE

GP-N-1 Replace int/ext 150-200W incandescents with 35 W HPS screw-in retrofits for explosion-proof applications *

$$\text{Energy savings} = (150\,W - 42\,W) \times \frac{24\,hr}{day} \times \frac{260\,days}{yr} = 674\,\frac{kwh}{yr}$$

$$\text{Energy Cost Savings} = 674\,\frac{kwh}{yr} \times \frac{\$0.03026}{kwh} = \frac{\$20.39}{yr}$$

$$\text{Labor \& Mat'l Cost Savings} = \left(\frac{\text{Incand. Cost}}{750\,hr} - \frac{\text{HPS Cost}}{16000\,hr}\right) \times 6240\,\frac{hr}{yr}$$

$$= \left[\frac{(\$2.11\,mat'l + \$1.20\,labor \times 0.683 \times 1.2\,exp\text{-}prf)}{750\,hr} - \frac{(\$16\,mat'l + \$6.45\,labor \times 0.683 \times 1.2)}{16{,}000\,hr}\right] \times \frac{6240\,hr}{yr} = \frac{\$17.44}{yr}$$

$$\text{Total Cost savings} = \frac{\$20.39}{yr} + \frac{\$17.44}{yr} = \frac{\$37.83}{yr}$$

Mat'l cost = \$45 for fixture w/ lamp (1990 vendor info.)

Labor cost = \$1.20 × 1.20 × 1.20 exp-proof × 0.683 = \$1.18
(Cost of replacing exp-proof incand. +20%)

$$\text{Project Cost} = [(1.045 \times \$45) + (1.2 \times \$1.18)] \times 1.661 = \$80.46$$

$$\text{Simple payback} = \frac{\$80.46}{\$37.83/yr} = 2.1\,yr < 10\,yr$$

Note: HPS lamps are replaceable in the retrofit ballasts.

* It must be verified that the screw-in retrofits will fit in all fixtures.

RS&H®

SUBJECT ______ AEP NO ______

SHEET ______ OF ______

DESIGNER ______ DATE ______

CHECKER ______ DATE ______

QRIP Calc's

Current energy use for 1740 lamps:

$\frac{150\ W}{1000} * 24 * 260 * 0.03026 * 1740 =$ #49,280/yr

Current mat'l & labor costs:

$\frac{2.11 + 1.2 * 0.68 * 1.2}{750} * 6240 * 1740 =$ # 44,781/yr

Current labor costs:

$\frac{1.2 \times 0.68}{750} \times 6240 * 1740 =$ # 11,813/yr

---

New energy use

$\frac{42\ W}{1000} * 24 * 260 * 0.03026 * 1740 =$ # 13,799/yr

New mat'l & labor costs:

$\frac{16 + 6.45 * 0.68 * 1.2}{16,000} * 6240 * 1740 =$ #14,429/yr

New labor costs

$\frac{6.45 * 0.68}{16,000} * 1.2 * 6240 * 1740 =$ #3572/yr

Radford Army Ammunition Plant
List of Buildings with Incandescent Lighting

Bldg No	Name/Process	Location	Similar	Fixtures/Bldg.	Total Fixtures
1000 -00	Cotton Linter Warehouse	NC, A&B-Line	1	17	17
1606 -00	Open Tank Air Dry	Sol. Recovery, A-Line	10	20	200
1611 -00	Solvent Recovery House	Sol. Recovery, B-Line	27	12	324
3513 -00	C-1 Press & Cutting House	Green, C-Line	3	20	60
4912 -27	SG Curing Hse.- Carpet Rolls	Cast Prop. (Rocket)	10	5	50
4924 -06	Machine and Saw House	Cast Prop. (Rocket)	1	6	6
7106 -04	Dry House #4 (Cure Grain)	1st R P	7	8	56
9334 -15	Blender House	4th Rolled Powder	1	4	4
TOTAL FOR EXTERIOR FIXTURES					717
420 -02	Acid Waste Disposal (C-Line)	Waste Acid	1	8	8
2019 -00	Boiling Tub House	NC, B-Line	3	50	150
2022 -00	Beater House	NC, B-Line	3	40	120
2024 -00	Poacher & Blending House	NC, B-Line	3	30	90
3513 -00	C-1 Press & Cutting House	Green, C-Line	3	50	150
4912 -40	Forced Air Dry House	Pilot B	21	10	210
4912 -11	LG Mold Loading House	Cast Prop. (Rocket)	2	6	12
4912 -03	MK 43 Sawing and Inhibiting	Cast Prop. (Rocket)	1	4	4
4915 -00	Small Grain Mold Assembly	Cast Prop. (Rocket)	1	7	7
4921 -00	Inspect/Clean NG Tanks *	Cast Prop. (Rocket)	1	21	21
4951 -02	TOW Launch Saw House	Pilot B	1	8	8
5008 -01	15 Inch Press House	Pilot A	3	2	6
6304 -00	Paste Blending House	1st R P	1	20	20
7113 -00	Roll House (Rolled Powder)	1st R P (F-Line)	1	130	130
9310 -02	Rolled Powder Building	4th Rolled Powder	2	300	600
TOTAL FOR INTERIOR FIXTURES					1536

CONSTRUCTION COST ESTIMATE

DATE PREPARED: 6-90

SHEET 4 OF 10

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: RADFORD ARMY AMMUNITION PLANT

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE:
- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.: GP-N-1

ESTIMATOR: T. Todd

CHECKED BY:

Incand. to 35W HPS SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
Replace incandescent lamps with 35W HPS screw-in retrofits	1740	fixt.	1.18	2053	45.00	78300	80353
Sales Tax	4.5%					3524	3524
FICA / Insurance	20.0%			411			411
Subtotal				2464		81824	84288
Overhead	15.0%						12643
Profit	10.0%						9693
Performance Bond	1.0%						1066
Hercules Support	6.0%						6461
Contingency	10.0%						11415
Construction Cost							125566

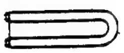
ECP ENERGY CONSERVATION PRODUCTS, 511 CANAL STREET, NYC, NY, 10013—TEL (212)-925-5991

POWER CONSUMPTION AND LUMEN OUTPUT DATA

	WATTS	LINE WATTS	TOTAL LUMEN OUTPUT	LUMENS PER WATT	HOURS OF RATED LIFE
********* MERCURY VAPOR (DELUXE WHITE)					
*	1000	1075	63000	59	24000
*	400	450	23000	56	24000
*	250	290	13000	42	24000
*	175	205	8500	49	24000
*	100	120	4500	42	24000
*	75	93	3150	37	16000
*	50	61	1680	31	16000
********* METAL HALIDE					
*	1500	1600	155000	103	3000
*	1000	1100	110000	100	12000
*	400	460	34000	85	15000
*	175	210	14000	85	7500
********* HIGH PRESSURE SODIUM					
*	1000	1080	140000	130	24000
*	400	480	50000	104	24000
*	250	310	27500	89	24000
*	150	200	16000	80	24000
*	100	135	9500	70	24000
*	70	85	5800	68	24000
*	50	70	4000	57	24000
*	35	42	2850	67	18000
*********FLUORESCENT					
STRAIGHT	40	48	3150	66	20000+
CIRCLINE	32	37	1830	50	12000+
CIRCLINE	22	25	1050	42	12000+
CIRCLINE	20	23	850	37	12000+
TWIN TUBE	13	16	900	56	10000+
TWIN TUBE	9	12	600	50	10000+
STRAIGHT	8	11	400	36	7500+
TWIN TUBE	7	10	400	40	10000+
STRAIGHT	6	9	300	33	7500+
TWIN TUBE	5	8	250	31	10000+
********* INCANDESCENT					
*	1000	1000	23740	24	1000
*	750	750	17040	23	1000
*	500	500	10850	22	1000
*	200	200	3710	19	750
*	150	150	2880	19	750
*	100	100	1750	18	750
*	75	75	1190	16	750
********* QUARTS—IODINE					
*	1500	1500	35800	24	3000
*	1000	1000	23400	23	2000
*	500	500	10950	22	2600
*	250	250	4850	19	2000

TP-N-1 p. 6 of 10

RAPID START FLUORESCENT U LAMPS



LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
FB40/U6/CW/EW	34	2,600	12,000	12
FB40/U6/CW	40	2,950	12,000	12

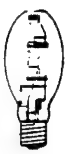
INSTANT START SLIMLINE FLUORESCENT LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
F72T12/CW	55	4,550	12,000	12
F96T12/CW/EW	60	5,600	15,000	15
F96T12/CW	75	6,200	12,000	15

HIGH & VERY HIGH OUTPUT FLUORESCENT LAMPS

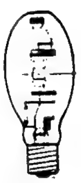
LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
F96T12/CW/HO/EW	95	8,300	12,000	15
F96T12/CW/HO	110	9,200	12,000	15
F96T12/CW/VHO/EW	185	14,000	12,000	15
F96T12/CW/VHO	215	15,500	12,000	15

METAL HALIDE UNIVERSAL BURN MEDIUM BASE LAMPS



LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
MH35/U	35	2,300	5,000	12
MH50/U	50	3,400	5,000	12
MH70/U	70	5,500	5,000	12
MH100/U	100	7,200	7,500	12
MH150/U	150	12,000	10,000	12

METAL HALIDE UNIVERSAL BURN MOGAL BASE LAMPS



LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
MH175/U	175	14,000	10,000	12
MH175/C/U	175	14,000	10,000	12
MH250/U	250	20,500	10,000	12
MH250/C/U	250	20,500	10,000	12
MH400/U	400	36,000	20,000	6
MH400/C/U	400	36,000	20,000	6
MH1000/U	1000	110,000	12,000	6
MH1000/C/U	1000	105,000	12,000	6

COMPACT DOUBLE ENDED HQI METAL HALIDE LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
HQI 70	70	5,000	10,000	12
HQI 150	150	11,000	10,000	12
HQI 250	250	19,000	10,000	12
HQI 400	400	25,000	10,000	12

HIGH PRESSURE SODIUM MEDIUM BASE LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
LU35/MED	35	2,250	16,000	12
LU35/D/MED	35	2,150	16,000	12
LU50/MED	50	4,000	24,000	12
LU50/D/MED	50	3,800	24,000	12
LU70/MED	70	6,300	24,000	12
LU70/D/MED	70	5,985	24,000	12
LU100/MED	100	9,500	24,000	12
LU100/D/MED	100	8,800	24,000	12
LU150/MED	150	16,000	24,000	12
LU150/D/MED	150	15,000	24,000	12

COLOR IMPROVED HIGH PRESSURE SODIUM LAMP

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
NHT50SDX	50	2,500	12,000	12

HIGH PRESSURE SODIUM ED-23½ MOGUL BASE LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
LU50	50	4,000	24,000	12
LU50/D	50	3,800	24,000	12
LU70	70	6,300	24,000	12
LU70/D	70	5,985	24,000	12
LU100	100	9,500	24,000	12
LU100/D	100	8,800	24,000	12
LU150/55	150	16,000	24,000	12
LU150/55/D	150	15,000	24,000	12

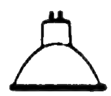
HIGH PRESSURE SODIUM E-18 MOGUL BASE LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
LU200	200	22,000	24,000	12
LU250	250	29,000	24,000	12
LU250/D	250	26,000	24,000	12
LU310	310	37,000	24,000	12
LU400	400	50,000	24,000	12

LOW PRESSURE SODIUM LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
SOX10	10	1,000	9,000	20
SOX18	18	1,800	14,000	20
SOX35	35	4,800	18,000	12
SOX55	55	8,000	18,000	9
SOX90	90	13,500	18,000	9
SOX135	135	22,500	18,000	9
SOX180	180	33,000	18,000	9

MR16 LOW VOLTAGE 12V TUNGSTEN HALOGEN LAMPS



LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
ESX (N)	20	3,300	2,000	20
BAB (W)	20	460	2,000	20
EYR (N)	42	7,300	2,000	20
EYS (M)	42	2,500	2,000	20
EYP (W)	42	1,200	2,000	20
EXT (N)	50	9,150	3,000	20
EXZ (M)	50	3,000	3,000	20
EXN (W)	50	1,500	3,000	20
EYF (N)	75	11,500	3,500	20
EYJ (M)	75	4,500	3,500	20
EYC (W)	75	2,000	3,500	20

MR16 LINE VOLTAGE 120V MEDIUM BASE TUNGSTEN HALOGEN LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
M/JDR75W/N	75	6,300	2,000	12
M/JDR75W/M	75	3,500	2,000	12
M/JDR75W/W	75	2,100	2,000	12
M/JDR100/N	100	8,500	2,000	12
M/JDR100/M	100	4,500	2,000	12
M/JDR100/W	100	3,000	2,000	12

MR16 LINE VOLTAGE 120V INTERMEDIATE BASE TUNGSTEN HALOGEN LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
I/JDR75W/N	75	6,300	2,000	12
I/JDR75W/M	75	3,500	2,000	12
I/JDR75W/W	75	2,100	2,000	12
I/JDR100/N	100	8,500	2,000	12
I/JDR100/M	100	4,500	2,000	12
I/JDR100/W	100	3,000	2,000	12

TUNGSTEN HALOGEN LINE VOLTAGE MEDIUM BASE TUBULAR LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
64484/CL	75	1,200	2,000	15
64484/FR	75	1,140	2,000	15
64486/CL	100	1,600	2,000	15
64486/FR	100	1,520	2,000	15
64488/CL	150	2,760	2,000	15
64488/FR	150	2,622	2,000	15

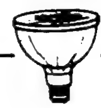
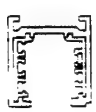
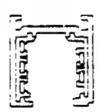
TUNGSTEN HALOGEN LINE VOLTAGE DOUBLE ENDED LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
Q100T3/CL	100	1,600	200	12
Q150T3/CL	150	2,800	200	12
Q200T3/CL	200	3,600	200	12
Q300T3/CL	300	6,000	200	12
Q500T3/CL	500	11,000	200	12
Q1500T3/CL	1500	33,000	200	12

GP-N-1 p. 7 of 10

166 100 | Lighting

		166 100 Lighting	CREW	DAILY OUTPUT	MAN-HOURS	UNIT	BARE COSTS MAT.	BARE COSTS LABOR	BARE COSTS EQUIP.	BARE COSTS TOTAL	TOTAL INCL O&P	
140	1600	90 watt	1 Elec	.30	26.670	C	5,140	645		5,785	6,600	140
	1650	135 watt		.20	40		6,905	970		7,875	9,025	
	1700	180 watt		.20	40		7,308	970		8,278	9,475	
	1750	Quartz line, clear, 500 watt		1.10	7.270		1,872	175		2,047	2,325	
	1760	1500 watt		.20	40		3,427	970		4,397	5,200	
	1800	Incandescent, interior, A21, 100 watt		1.60	5		173	120		293	370	
	1900	A21, 150 watt		1.60	5		211	120		331	410	
	2000	A23, 200 watt		1.60	5		227	120		347	430	
	2200	PS 30, 300 watt		1.60	5		330	120		450	540	
	2210	PS 35, 500 watt		1.60	5		576	120		696	810	
	2230	PS 52, 1000 watt		1.30	6.150		1,525	150		1,675	1,900	
	2240	PS 52, 1500 watt		1.30	6.150		2,382	150		2,532	2,850	
	2300	R30, 75 watt		1.30	6.150		375	150		525	630	
	2400	R40, 150 watt		1.30	6.150		408	150		558	670	
	2500	Exterior, PAR 38, 75 watt		1.30	6.150		566	150		716	840	
	2600	PAR 38, 150 watt		1.30	6.150		525	150		675	795	
	2700	PAR 46, 200 watt		1.10	7.270		1,928	175		2,103	2,375	
	2800	PAR 56, 300 watt		1.10	7.270		2,193	175		2,368	2,675	
	3000	Guards, fluorescent lamp, 4' long		1	8		375	195		570	695	
	3200	8' long		.90	8.890		535	215		750	905	
145	0010	RESIDENTIAL FIXTURES										145
	0400	Fluorescent, interior, surface, circline, 32 watt & 40 watt	1 Elec	20	.400	Ea.	48	9.70		57.70	67	
	0500	2' x 2', two U 40 watt		8	1		66	24		90	110	
	0700	Shallow under cabinet, two 20 watt		16	.500		45	12.15		57.15	67	
	0900	Wall mounted, 4'L, one 40 watt, with baffle		10	.800		41	19.40		60.40	74	
	[illegible]000	Incandescent, exterior lantern, wall mounted, 60 watt		16	.500		36	12.15		48.15	57	
	[illegible]100	Post light, 150W, with 7' post		4	2		104	49		153	185	
	2500	Lamp holder, weatherproof with 150W PAR		16	.500		16	12.15		28.15	35	
	2550	With reflector and guard		12	.667		31	16.15		47.15	58	
	2600	Interior pendent, globe with shade, 150 watt		20	.400		78	9.70		87.70	100	
150	0010	TRACK LIGHTING										150
	0080	Track, 1 circuit, 4' section	1 Elec	6.70	1.190	Ea.	33	29		62	79	
	0100	8' section		5.30	1.510		48	37		85	105	
	0200	12' section		4.40	1.820		81	44		125	155	
	0300	3 circuits, 4' section		6.70	1.190		36	29		65	82	
	0400	8' section		5.30	1.510		48	37		85	105	
	0500	12' section		4.40	1.820		88	44		132	160	
	1000	Feed kit, surface mounting		16	.500		12	12.15		24.15	31	
	1100	End cover		24	.333		1.98	8.10		10.08	14.05	
	1200	Feed kit, stem mounting, 1 circuit		16	.500		16	12.15		28.15	35	
	1300	3 circuit		16	.500		16	12.15		28.15	35	
	2000	Electrical joiner for continuous runs, 1 circuit		32	.250		6.55	6.05		12.60	16.10	
	2100	3 circuit		32	.250		12.10	6.05		18.15	22	
	2200	Fixtures, spotlight, 150 PAR		16	.500		47	12.15		59.15	70	
	3000	Wall washer, 250 watt tungsten halogen		16	.500		101	12.15		113.15	130	
	3100	Low voltage, 25/50 watt, 1 circuit		16	.500		102	12.15		114.15	130	
	3120	3 circuit		16	.500		109	12.15		121.15	140	

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166 100 | Lighting

	166 100 Lighting	CREW	DAILY OUTPUT	MAN-HOURS	UNIT	BARE COSTS MAT.	BARE COSTS LABOR	BARE COSTS EQUIP.	BARE COSTS TOTAL	TOTAL INCL O&P	
135	5100 175 watt metal halide	1 Elec	8	1	Ea.	479	24		503	565	135
	5110 250 watt metal halide		8	1		500	24		524	585	
	5120 150 watt high pressure sodium		8	1		535	24		559	625	
	5130 250 watt high pressure sodium		8	1		556	24		580	645	
	5140 72"H 18" sq., 400 watt metal halide		8	1		525	24		549	615	
	5150 250 watt high pressure sodium		8	1		556	24		580	645	
	5160 400 watt high pressure sodium	↓	8	1	↓	581	24		605	675	
	5190 Portable rectangle, 6" high 13.5" x 20"										
	5200 175 watt metal halide	1 Elec	12	.667	Ea.	293	16.15		309.15	345	
	5210 250 watt metal halide		12	.667		314	16.15		330.15	370	
	5220 150 watt high pressure sodium		12	.667		335	16.15		351.15	390	
	5230 250 watt high pressure sodium		12	.667		360	16.15		376.15	420	
	5240 8" high 18" x 24", 400 watt metal halide		12	.667		365	16.15		381.15	425	
	5250 250 watt high pressure sodium		12	.667		376	16.15		392.15	435	
	5260 400 watt high pressure sodium		12	.667		398	16.15		414.15	460	
	5270 Portable square, 15" high 13.5" sq., 175 watt metal halide		12	.667		324	16.15		340.15	380	
	5280 250 watt metal halide		12	.667		376	16.15		392.15	435	
	5290 150 watt high pressure sodium		12	.667		360	16.15		376.15	420	
	5300 250 watt high pressure sodium		12	.667		386	16.15		402.15	450	
	5400 Pendent 16" round/square, 175 watt metal halide		3.20	2.500		355	61		416	480	
	5410 250 watt metal halide		2.70	2.960		370	72		442	515	
	5420 400 watt metal halide		2.40	3.330		398	81		479	555	
	5430 150 watt high pressure sodium		3.20	2.500		398	61		459	525	
	5440 250 watt high pressure sodium		2.70	2.960		428	72		500	575	
	5450 400 watt high pressure sodium	↓	2.40	3.330	↓	454	81		535	620	
140	0010 LAMPS										140
	0080 Fluorescent, rapid start, cool white, 2' long, 20 watt	1 Elec	1	8	C	348	195		543	670	
	0100 4' long, 40 watt		.90	8.890		198	215		413	535	
	0120 3' long, 30 watt		.90	8.890		442	215		657	805	
	0150 U-40 watt		.80	10		874	245		1,119	1,325	
	0170 4' long, 35 watt energy saver		.90	8.890		270	215		485	615	
	0200 Slimline, 4' long, 40 watt		.90	8.890		618	215		833	995	
	0300 8' long, 75 watt		.80	10		577	245		822	990	
	0350 8' long, 60 watt energy saver		.80	10		603	245		848	1,025	
	0400 High output, 4' long, 60 watt		.90	8.890		750	215		965	1,150	
	0500 8' long, 110 watt		.80	10		775	245		1,020	1,200	
	0520 Very high output, 4' long, 110 watt		.90	8.890		1,285	215		1,500	1,725	
	0550 8' long, 215 watt		.70	11.430		1,285	275		1,560	1,825	
	0600 Mercury vapor, mogul base, deluxe white, 100 watt		.30	26.670		2,142	645		2,787	3,300	
	0650 175 watt		.30	26.670		1,663	645		2,308	2,775	
	0700 250 watt		.30	26.670		2,968	645		3,613	4,225	
	0800 400 watt		.30	26.670		2,340	645		2,985	3,525	
	0900 1000 watt		.20	40		5,100	970		6,070	7,025	
	1000 Metal halide, mogul base, 175 watt		.30	26.670		3,749	645		4,394	5,075	
	1100 250 watt		.30	26.670		4,712	645		5,357	6,125	
	1200 400 watt		.30	26.670		4,386	645		5,031	5,775	
	1300 1000 watt		.20	40		9,894	970		10,864	12,300	
	1320 1000 watt, 125,000 initial lumens		.20	40		9,960	970		10,930	12,400	
	1330 1500 watt		.20	40		9,268	970		10,238	11,600	
	1350 Sodium high pressure, 70 watt		.30	26.670		4,712	645		5,357	6,125	
	1360 100 watt		.30	26.670		4,871	645		5,516	6,300	
	1370 150 watt		.30	26.670		5,059	645		5,704	6,525	
	1380 250 watt		.30	26.670		5,380	645		6,025	6,875	
	1400 400 watt		.30	26.670		5,727	645		6,372	7,250	
	1450 1000 watt		.20	40		13,352	970		14,322	16,100	
	1500 Low pressure, 35 watt		.30	26.670		3,963	645		4,608	5,300	
	1550 55 watt	↓	.30	26.670	↓	4,386	645		5,031	5,775	

HUNTER **Telephone Call Confirmation**

Project No. 290 0379000

Local ______ L.D. (718) 851-4577 Placed ✓ Rec'd. ✓ Date 6-7-90

T. Todd Conversed With Mr. Singer

Of American Scientific Lighting Co. Regarding HPS retrofits

For retrofits of incandescent fixtures, the "Bulb Lumenight" and "Colorlight" products are recommended. The lamps are replaceable in both and the "colorlight" is more whitish. Contractors costs (including lamp) for quantities of 100+ are as follows:

Bulb Lumenight 35 W – $45 (lamps only
50 W – $45 $16 – $20)
(also come in 70 W, 100 W, 150 W)

Colorlight 50 W – $67 (lamps only
$30)

They will send a copy of their catalog for dimensions.

Distribution:

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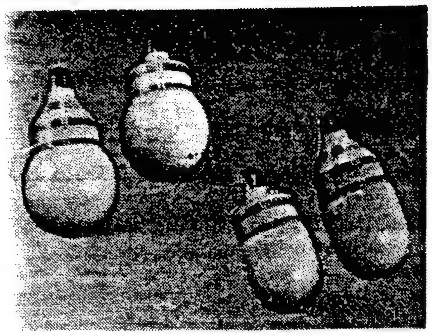
FLUOR-A-LAMP™ SERIES: COMPACT FLUORESCENT LAMPS

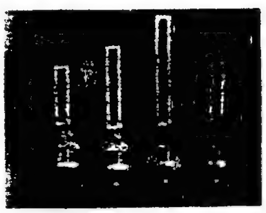


GLOBE LAMP/LUMA LAMP

- **LAMP:** Compact disposable fluorescent globe or tubular lamp/standard or tapered base
- **WATTAGE:** Fifteen
- **LUMENS:** 720
- **COLOR:** Warm white/2800k
- **USE:** Indoor only
- **BURNING POSITION:** Any
- **LAMP LIFE:** 9,000 hours
- **INSTALLATION:** Screws into any 120V medium base socket
- **PACKAGING:** Ten lamps per master carton

CATALOG NUMBER	LAMP	DIMENSIONS
FGL S/15	BFG15 LE/A	Lamp Diameter 3¾" Overall Length 6¼"
FGL T/15	BFG15 LE/T	Lamp Diameter 3¾" Overall Length 6¾"
FLL S/15	BFT15 LE/A	Lamp Diameter 3⅛" Overall Length 6⅝"
FLL T/15	BFT15 LE/T	Lamp Diameter 3⅛" Overall Length 7"

CONVERT-A-LITE™ SERIES: SCREW-IN FLUORESCENT ADAPTER CONVERSIONS



ECONOMY CUP CONVERSION

- **ADAPTER:** Molded Norel® thermal plastic/Sealed and potted to protect internal components
- **FINISH:** White
- **LAMP:** Centered on top of adapter/Not dimmable
- **INSTALLATION:** Adapter screws into any standard 120v medium based socket/No additional wiring or modified circuitry required
- **PACKAGING:** Bulk packed/Lamp included

CATALOG NUMBER	LAMP	DIMENSIONS
		Adapter Diameter 2⅛"
CC/5/E	PL5	Overall Length 6⅜"
CC/7/E	PL7	Overall Length 7½"
CC/9/E	PL9	Overall Length 8⅞"
CC/13/E	PL13	Overall Length 9 11/16"
CC/Q9/E	Quad 9	Overall Length 6⅝"
CC/Q13/E	Quad 13	Overall Length 7"

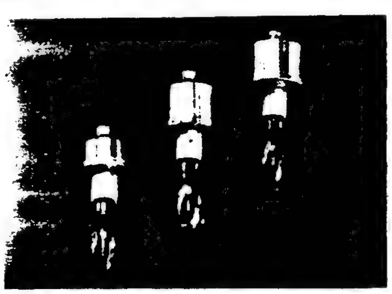
PREMIUM CUP CONVERSION

- **ADAPTER:** Molded Norel® thermal plastic/Sealed to protect internal components
- **FINISH:** Black
- **LAMP:** Centered/Recessed inside of adapter/Not dimmable
- **INSTALLATION:** Adapter screws into any standard 120v medium base socket/No additional wiring or modified circuitry required/Ratched screw base prevents over tightening
- **PACKAGING:** Bulk packed/Lamp included

CATALOG NUMBER	LAMP	DIMENSIONS
		Adapter Diameter 2¾"
CC/5/P	PL5	Overall Length 5½"
CC/7/P	PL7	Overall Length 6 13/16"
CC/9/P	PL9	Overall Length 8"
CC/13/P	PL13	Overall Length 8 13/16"
CC/Q9/P	QUAD 9	Overall Length 5⅞"
CC/Q13/P	QUAD 13	Overall Length 6¼"
CC/Q22/P	QUAD 22	Overall Length 8⅝"
CC/Q28/P	QUAD 28	Overall Length 9 1/16

PREMIUM OPTIONS:
DWC Direct Wire—Center **SWS** Direct Wire—Side

CONVERT-A-LITE™ SERIES: SCREW-IN HPS ADAPTER CONVERSIONS



BULB LUMENIGHT™

- **ADAPTER:** Heavy gauge spun aluminum
- **FINISH:** Caustic etching
- **INSTALLATION:** Adapter screws into a standard 120V medium base porcelin socket/No additional wiring or modified circuitry required/Safety weight ground wire
- **PACKAGING:** Four per carton/Lamp included

CATALOG NUMBER	LAMP	DIMENSIONS
BL/35	LU35	Diameter 3⅛"
BL/50	LU50	Overall Length 9⅜"
BL/70	LU70	Diameter 3¼" Overall Length 10 1/16"
BL/100	LU100	Diameter 4"
BL/150	LU150	Overall Length 10⅞"

OPTIONS:
HBR High Bay Reflector **DW** Direct Wire
LBR Low Bay Reflector

GP-N-2 REPLACE INCANDESCENTS WITH CIRCLINE FLUORESCENTS

Calculations were made on a per-unit basis for installing 32 W circline fluorescent fixtures in place of incandescents for interior non-explosion proof applications. The per-unit calculations are on page 2. From the building survey data, a list of the buildings with potential incandescent lighting projects was compiled (page 3). It is assumed for this ECO that 10% of the interior fixtures are non-explosion proof and can be retrofitted in this manner. Only areas operating 3 shifts/day, 5 days/wk were considered.

Total fixtures = 0.1 × 1536 = 154

Energy savings = $705 \frac{kwh}{yr} \times 0.003413 \frac{MBtu}{kwh} \times 154 = 371$ MBtu/yr

Energy cost savings = $\frac{\$21.34}{yr\text{-}fixture} \times 154$ fixtures = \$3286/yr

Mat'l & labor cost savings = $\frac{\$20.33}{yr\text{-}fixture} \times 154 = \$3131$/yr

Total cost savings = 3286 + 3131 = \$6417/yr

Project cost = $\frac{\$94.47}{fixture} \times 154 = \$14,548$

(Construction cost = 14,548 / 1.115 = \$13,048)

Simple payback = $\frac{\$14,548}{\$6417/yr} = 2.3$ yr

GP-N-2 Replace interior 100-150W incandescents with 32 W screw-in fluorescent fixtures for non-explosion proof applications

- Assume original light levels should not be reduced significantly.

(32 W fluor. provides lumen output between 100W and 150W incand.)

$$\text{Energy savings} = (150\,W - 37\,W) \times \frac{24\,hr}{day} \times \frac{260\,days}{yr} = 705\ \frac{kwh}{yr}$$

$$\text{Energy cost savings} = 705\ \frac{kwh}{yr} \times \frac{\$0.03026}{kwh} = \frac{\$21.34}{yr}$$

$$\text{Labor \& mat'l cost savings} = \left(\frac{\text{Incand. cost}}{750\,hr} - \frac{\text{Fluor. cost}}{12{,}000\,hr}\right) \times 6240\ \frac{hr}{yr}$$

$$= \left[\frac{(\$2.11\ \text{mat'l} + \$1.20\ \text{labor} \times 0.683)}{750\,hr} - \frac{(\$5.55 \times 1.1\ \text{mat'l} + \$2.45\ \text{labor} \times 0.683)}{12{,}000\,hr}\right] \times 6240\ \frac{hr}{yr} = \frac{\$20.33}{yr}$$

$$\text{Total cost savings} = \frac{\$21.34}{yr} + \frac{\$20.33}{yr} = \frac{\$41.67}{yr}$$

Mat'l cost = \$42.90 for fixture × 1.10 inflation (1984 vendor literature) + \$5.55 for lamp × 1.10 infl. = \$53.30

Labor cost = \$1.20 × 1.20 × 0.683 (cost of replacing incand. bulb + 20%)

$$\text{Project cost} = [(1.045 \times \$53.30) + (1.2 \times \$0.98)] \times 1.661 = \$94.47$$

$$\text{Simple payback} = \frac{\$94.47}{\$41.67/yr} = 2.3\ yr < 10\ yr.$$

Radford Army Ammunition Plant
List of Buildings with Incandescent Lighting

Bldg No	Name/Process	Location	Similar	Fixtures/Bldg.	Total Fixtures
1000 -00	Cotton Linter Warehouse	NC, A&B-Line	1	17	17
1606 -00	Open Tank Air Dry	Sol. Recovery, A-Line	10	20	200
1611 -00	Solvent Recovery House	Sol. Recovery, B-Line	27	12	324
3513 -00	C-1 Press & Cutting House	Green, C-Line	3	20	60
4912 -27	SG Curing Hse.- Carpet Rolls	Cast Prop. (Rocket)	10	5	50
4924 -06	Machine and Saw House	Cast Prop. (Rocket)	1	6	6
7106 -04	Dry House #4 (Cure Grain)	1st R P	7	8	56
9334 -15	Blender House	4th Rolled Powder	1	4	4
TOTAL FOR EXTERIOR FIXTURES					717
420 -02	Acid Waste Disposal (C-Line)	Waste Acid	1	8	8
2019 -00	Boiling Tub House	NC, B-Line	3	50	150
2022 -00	Beater House	NC, B-Line	3	40	120
2024 -00	Poacher & Blending House	NC, B-Line	3	30	90
3513 -00	C-1 Press & Cutting House	Green, C-Line	3	50	150
4912 -40	Forced Air Dry House	Pilot B	21	10	210
4912 -11	LG Mold Loading House	Cast Prop. (Rocket)	2	6	12
4912 -03	MK 43 Sawing and Inhibiting	Cast Prop. (Rocket)	1	4	4
4915 -00	Small Grain Mold Assembly	Cast Prop. (Rocket)	1	7	7
4921 -00	Inspect/Clean NG Tanks *	Cast Prop. (Rocket)	1	21	21
4951 -02	TOW Launch Saw House	Pilot B	1	8	8
5008 -01	15 Inch Press House	Pilot A	3	2	6
6304 -00	Paste Blending House	1st R P	1	20	20
7113 -00	Roll House (Rolled Powder)	1st R P (F-Line)	1	130	130
9310 -02	Rolled Powder Building	4th Rolled Powder	2	300	600
TOTAL FOR INTERIOR FIXTURES					1536

CONSTRUCTION COST ESTIMATE	DATE PREPARED 6/90	SHEET 4 OF 11

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: RADFORD ARMY AMMUNITION PLANT

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE
- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO. GP-N-2 | ESTIMATOR T. Todd | CHECKED BY

Incand. to fluor. SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Replace incandescent lamps with 32W fluor. circline screw-ins	154	fixt.	0.98	151	53.30	8208	8359
Sales tax	4.5%					369	369
FICA / Insurance	20.0%			30			30
Subtotal				181		8577	8758
Overhead	15.0%						1314
Profit	10.0%						1007
Performance Bond	1.0%						111
Hercules Support	6.0%						671
Contingency	10.0%						1186
Construction Cost							13047

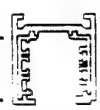
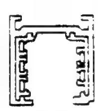
ECP ENERGY CONSERVATION PRODUCTS, 511 CANAL STREET, NYC, NY, 10013—TEL (212)-925-5991

POWER CONSUMPTION AND LUMEN OUTPUT DATA

	WATTS	LINE WATTS	TOTAL LUMEN OUTPUT	LUMENS PER WATT	HOURS OF RATED LIFE
********* MERCURY VAPOR (DELUXE WHITE)					
*	1000	1075	63000	59	24000
*	400	450	23000	56	24000
*	250	290	13000	42	24000
*	175	205	8500	49	24000
*	100	120	4500	42	24000
*	75	93	3150	37	16000
*	50	61	1680	31	16000
********* METAL HALIDE					
*	1500	1600	155000	103	3000
*	1000	1100	110000	100	12000
*	400	460	34000	85	15000
*	175	210	14000	85	7500
********* HIGH PRESSURE SODIUM					
*	1000	1080	140000	130	24000
*	400	480	50000	104	24000
*	250	310	27500	89	24000
*	150	200	16000	80	24000
*	100	135	9500	70	24000
	70	85	5800	68	24000
	50	70	4000	57	24000
*	35	42	2850	67	18000
*********FLUORESCENT					
STRAIGHT	40	48	3150	66	20000+
CIRCLINE	32	37	1830	50	12000+
CIRCLINE	22	25	1050	42	12000+
CIRCLINE	20	23	850	37	12000+
TWIN TUBE	13	16	900	56	10000+
TWIN TUBE	9	12	600	50	10000+
STRAIGHT	8	11	400	36	7500+
TWIN TUBE	7	10	400	40	10000+
STRAIGHT	6	9	300	33	7500+
TWIN TUBE	5	8	250	31	10000+
********* INCANDESCENT					
*	1000	1000	23740	24	1000
*	750	750	17040	23	1000
*	500	500	10850	22	1000
*	200	200	3710	19	750
*	150	150	2880	19	750
*	100	100	1750	18	750
*	75	75	1190	16	750
****** QUARTS—IODINE					
*	1500	1500	35800	24	3000
*	1000	1000	23400	23	2000
*	500	500	10950	22	2600
*	250	250	4850	19	2000

GP-N-2 p. 6 of 11

166 100 | Lighting

		166 100 Lighting	CREW	DAILY OUTPUT	MAN-HOURS	UNIT	BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
140	1600	90 watt	1 Elec	.30	26.670	C	5,140	645		5,785	6,600	140
	1650	135 watt		.20	40		6,905	970		7,875	9,025	
	1700	180 watt		.20	40		7,308	970		8,278	9,475	
	1750	Quartz line, clear, 500 watt		1.10	7.270		1,872	175		2,047	2,325	
	1760	1500 watt		.20	40		3,427	970		4,397	5,200	
	1800	Incandescent, interior, A21, 100 watt		1.60	5		173	120		293	370	
	1900	A21, 150 watt		1.60	5		211	120		331	410	
	2000	A23, 200 watt		1.60	5		227	120		347	430	
	2200	PS 30, 300 watt 		1.60	5		330	120		450	540	
	2210	PS 35, 500 watt		1.60	5		576	120		696	810	
	2230	PS 52, 1000 watt		1.30	6.150		1,525	150		1,675	1,900	
	2240	PS 52, 1500 watt		1.30	6.150		2,382	150		2,532	2,850	
	2300	R30, 75 watt		1.30	6.150		375	150		525	630	
	2400	R40, 150 watt		1.30	6.150		408	150		558	670	
	2500	Exterior, PAR 38, 75 watt 		1.30	6.150		566	150		716	840	
	2600	PAR 38, 150 watt		1.30	6.150		525	150		675	795	
	2700	PAR 46, 200 watt		1.10	7.270		1,928	175		2,103	2,375	
	2800	PAR 56, 300 watt		1.10	7.270		2,193	175		2,368	2,675	
	3000	Guards, fluorescent lamp, 4' long		1	8		375	195		570	695	
	3200	8' long		.90	8.890		535	215		750	905	
145	0010	**RESIDENTIAL FIXTURES**										145
	0400	Fluorescent, interior, surface, circline, 32 watt & 40 watt	1 Elec	20	.400	Ea.	48	9.70		57.70	67	
	0500	2' x 2', two U 40 watt		8	1		66	24		90	110	
	0700	Shallow under cabinet, two 20 watt		16	.500		45	12.15		57.15	67	
	0900	Wall mounted, 4'L, one 40 watt, with baffle		10	.800		41	19.40		60.40	74	
	2000	Incandescent, exterior lantern, wall mounted, 60 watt		16	.500		36	12.15		48.15	57	
	2100	Post light, 150W, with 7' post		4	2		104	49		153	185	
	2500	Lamp holder, weatherproof with 150W PAR		16	.500		16	12.15		28.15	35	
	2550	With reflector and guard		12	.667		31	16.15		47.15	58	
	2600	Interior pendent, globe with shade, 150 watt		20	.400		78	9.70		87.70	100	
150	0010	**TRACK LIGHTING**										150
	0080	Track, 1 circuit, 4' section 	1 Elec	6.70	1.190	Ea.	33	29		62	79	
	0100	8' section		5.30	1.510		48	37		85	105	
	0200	12' section		4.40	1.820		81	44		125	155	
	0300	3 circuits, 4' section 		6.70	1.190		36	29		65	82	
	0400	8' section		5.30	1.510		48	37		85	105	
	0500	12' section		4.40	1.820		88	44		132	160	
	1000	Feed kit, surface mounting		16	.500		12	12.15		24.15	31	
	1100	End cover		24	.333		1.98	8.10		10.08	14.05	
	1200	Feed kit, stem mounting, 1 circuit		16	.500		16	12.15		28.15	35	
	1300	3 circuit		16	.500		16	12.15		28.15	35	
	2000	Electrical joiner for continuous runs, 1 circuit		32	.250		6.55	6.05		12.60	16.10	
	2100	3 circuit		32	.250		12.10	6.05		18.15	22	
	2200	Fixtures, spotlight, 150 PAR 		16	.500		47	12.15		59.15	70	
	3000	Wall washer, 250 watt tungsten halogen		16	.500		101	12.15		113.15	130	
	3100	Low voltage, 25/50 watt, 1 circuit		16	.500		102	12.15		114.15	130	
	3120	3 circuit		16	.500		109	12.15		121.15	140	

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166 100 | Lighting

			CREW	DAILY OUTPUT	MAN-HOURS	UNIT	BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
135	5100	175 watt metal halide	1 Elec	8	1	Ea.	479	24		503	565	135
	5110	250 watt metal halide		8	1		500	24		524	585	
	5120	150 watt high pressure sodium		8	1		535	24		559	625	
	5130	250 watt high pressure sodium		8	1		556	24		580	645	
	5140	72"H 18" sq., 400 watt metal halide		8	1		525	24		549	615	
	5150	250 watt high pressure sodium		8	1		556	24		580	645	
	5160	400 watt high pressure sodium		8	1		581	24		605	675	
	5190	Portable rectangle, 6" high 13.5" x 20"										
	5200	175 watt metal halide	1 Elec	12	.667	Ea.	293	16.15		309.15	345	
	5210	250 watt metal halide		12	.667		314	16.15		330.15	370	
	5220	150 watt high pressure sodium		12	.667		335	16.15		351.15	390	
	5230	250 watt high pressure sodium		12	.667		360	16.15		376.15	420	
	5240	8" high 18" x 24", 400 watt metal halide		12	.667		365	16.15		381.15	425	
	5250	250 watt high pressure sodium		12	.667		376	16.15		392.15	435	
	5260	400 watt high pressure sodium		12	.667		398	16.15		414.15	460	
	5270	Portable square, 15" high 13.5" sq., 175 watt metal halide		12	.667		324	16.15		340.15	380	
	5280	250 watt metal halide		12	.667		376	16.15		392.15	435	
	5290	150 watt high pressure sodium		12	.667		360	16.15		376.15	420	
	5300	250 watt high pressure sodium		12	.667		386	16.15		402.15	450	
	5400	Pendent 16" round/square, 175 watt metal halide		3.20	2.500		355	61		416	480	
	5410	250 watt metal halide		2.70	2.960		370	72		442	515	
	5420	400 watt metal halide		2.40	3.330		398	81		479	555	
	5430	150 watt high pressure sodium		3.20	2.500		398	61		459	525	
	5440	250 watt high pressure sodium		2.70	2.960		428	72		500	575	
	5450	400 watt high pressure sodium		2.40	3.330		454	81		535	620	
140	0010	LAMPS										140
	0080	Fluorescent, rapid start, cool white, 2' long, 20 watt	1 Elec	1	8	C	348	195		543	670	
	0100	4' long, 40 watt		.90	8.890		198	215		413	535	
	0120	3' long, 30 watt		.90	8.890		442	215		657	805	
	0150	U-40 watt		.80	10		874	245		1,119	1,325	
	0170	4' long, 35 watt energy saver		.90	8.890		270	215		485	615	
	0200	Slimline, 4' long, 40 watt		.90	8.890		618	215		833	995	
	0300	8' long, 75 watt		.80	10		577	245		822	990	
	0350	8' long, 60 watt energy saver		.80	10		603	245		848	1,025	
	0400	High output, 4' long, 60 watt		.90	8.890		750	215		965	1,150	
	0500	8' long, 110 watt		.80	10		775	245		1,020	1,200	
	0520	Very high output, 4' long, 110 watt		.90	8.890		1,285	215		1,500	1,725	
	0550	8' long, 215 watt		.70	11.430		1,285	275		1,560	1,825	
	0600	Mercury vapor, mogul base, deluxe white, 100 watt		.30	26.670		2,142	645		2,787	3,300	
	0650	175 watt		.30	26.670		1,663	645		2,308	2,775	
	0700	250 watt		.30	26.670		2,968	645		3,613	4,225	
	0800	400 watt		.30	26.670		2,340	645		2,985	3,525	
	0900	1000 watt		.20	40		5,100	970		6,070	7,025	
	1000	Metal halide, mogul base, 175 watt		.30	26.670		3,749	645		4,394	5,075	
	1100	250 watt		.30	26.670		4,712	645		5,357	6,125	
	1200	400 watt		.30	26.670		4,386	645		5,031	5,775	
	1300	1000 watt		.20	40		9,894	970		10,864	12,300	
	1320	1000 watt, 125,000 initial lumens		.20	40		9,960	970		10,930	12,400	
	1330	1500 watt		.20	40		9,268	970		10,238	11,600	
	1350	Sodium high pressure, 70 watt		.30	26.670		4,712	645		5,357	6,125	
	1360	100 watt		.30	26.670		4,871	645		5,516	6,300	
	1370	150 watt		.30	26.670		5,059	645		5,704	6,525	
	1380	250 watt		.30	26.670		5,380	645		6,025	6,875	
	1400	400 watt		.30	26.670		5,727	645		6,372	7,250	
	1450	1000 watt		.20	40		13,352	970		14,322	16,100	
	1500	Low pressure, 35 watt		.30	26.670		3,963	645		4,608	5,300	
	1550	55 watt		.30	26.670		4,386	645		5,031	5,775	

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ECP ENERGY CONSERVATION PRODUCTS
511 CANAL STREET NEW YORK, N.Y. 10013

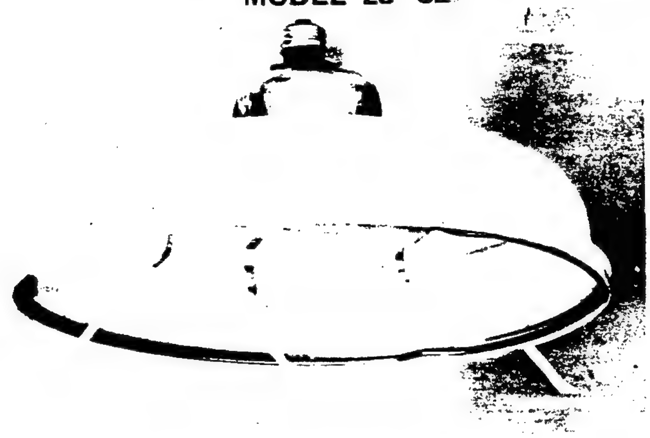
EFFECTIVE 3/1/84
(212)925-5991

LAMP PRICES

ORDERING CODE	TYPE	WATTAGE	LIST	CONT.	MIN QTY
F4T5/CW	FLUORESCENT	4	6.37	3.19	12
F4T5/WW	FLUORESCENT	4	7.17	3.59	12
F6T5/CW	FLUORESCENT	6	6.37	3.20	12
F6T5/WW	FLUORESCENT	6	8.79	4.40	12
F8T5/CW	FLUORESCENT	8	6.03	3.02	12
F8T5/WW	FLUORESCENT	8	7.15	3.58	12
FC6T9/CW	FLUORESCENT	20	10.00	5.00	12
FC6T9/WW	FLUORESCENT	20	11.35	5.68	12
FC8T9/CW	FLUORESCENT	22	10.00	5.00	12
FC8T9/WW	FLUORESCENT	22	11.35	5.68	12
FC12T9/CW	FLUORESCENT	32	11.10	5.55	12
FC12T9/WW	FLUORESCENT	32	12.50	6.25	12
FC16T9/CW	FLUORESCENT	40	13.00	6.50	12
FC16T9/WW	FLUORESCENT	40	14.75	7.38	12
PL-7	FLUORESCENT	7	13.00	6.50	10
PL-9	FLUORESCENT	9	13.00	6.50	10
PL-13	FLUORESCENT	13	14.00	7.00	10
LU-35	H.P.S.	35	70.00	35.00	6
LU-50	H.P.S.	50	70.00	35.00	6
LU-70	H.P.S.	70	70.00	35.00	6
LU-100	H.P.S.	100	80.00	40.00	6
LU-150	H.P.S.	150	80.00	40.00	6
ESX (NARROW)	QUARTZ HALOGEN	20	20.00	10.00	4
BAB (WIDE)	QUARTZ HALOGEN	20	20.00	10.00	4
EXT (NARROW)	QUARTZ HALOGEN	50	21.00	10.50	4
EXN (WIDE)	QUARTZ HALOGEN	50	21.00	10.50	4
EYF (NARROW)	QUARTZ HALOGEN	75	22.00	11.00	4
EYC (WIDE)	QUARTZ HALOGEN	75	22.00	11.00	4

ORDERS UNDER MINIMUM ADD 10%

MODEL 23 - 32

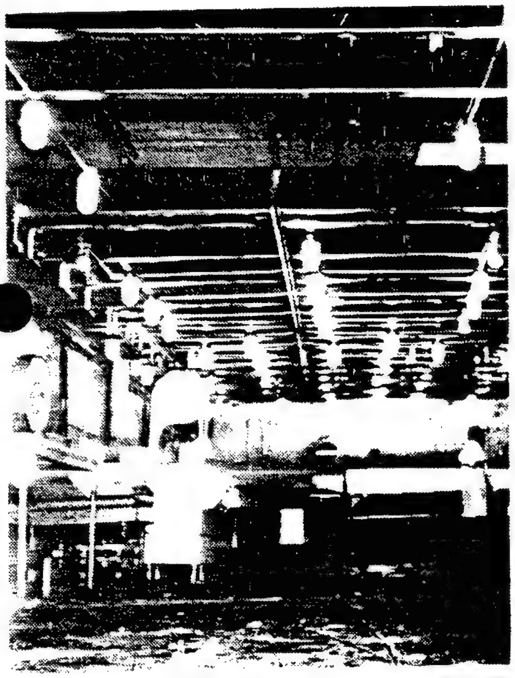


SAVE OVER $62^{00} PER FIXTURE, PER YEAR

UL

with 32 watt screw-in flourescent fixture... replaces 150 watt bulb

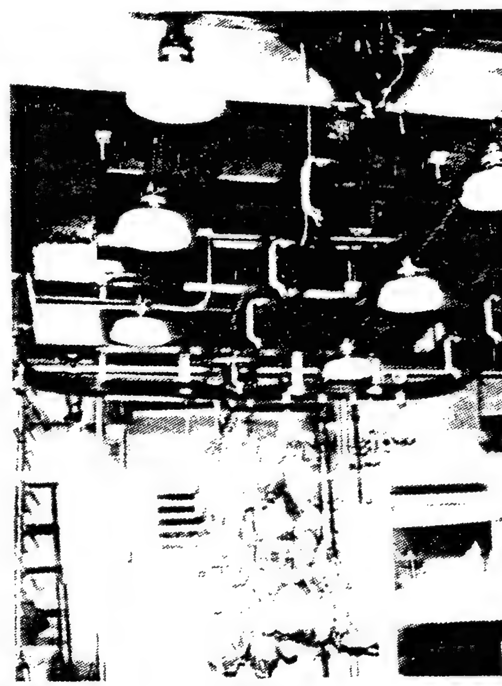
(available in 54 watts)



Before

Advantages

1. Immediate savings (no rewiring)
2. Long life (12,000 hrs)
3. Unbreakable (poly carbonate) lens
4. Reduced heat load (saves on refrigeration costs)
5. Easy cleaning
6. Equal illumination



After

COMPARE COSTS*

150 watt RS/TF incandescent bulb vs. 32 watt flourescent screw-in				savings
Energy Cost	$46.80	vs	$11.54 (Including Ballast)	$32.56
Lamp & maintenance cost	$21.31	vs	$ 1.82	$19.49
By reducing the heat load caused by the incandescent bulb, you can achieve additional savings on refrigeration costs				$10.85
			Total Savings	$62.90

* Based on 12 hour burn 5 days per week

DISTRIBUTED BY:

MFG. BY ECP® NEW YORK

GP-11-2 p. 10-11

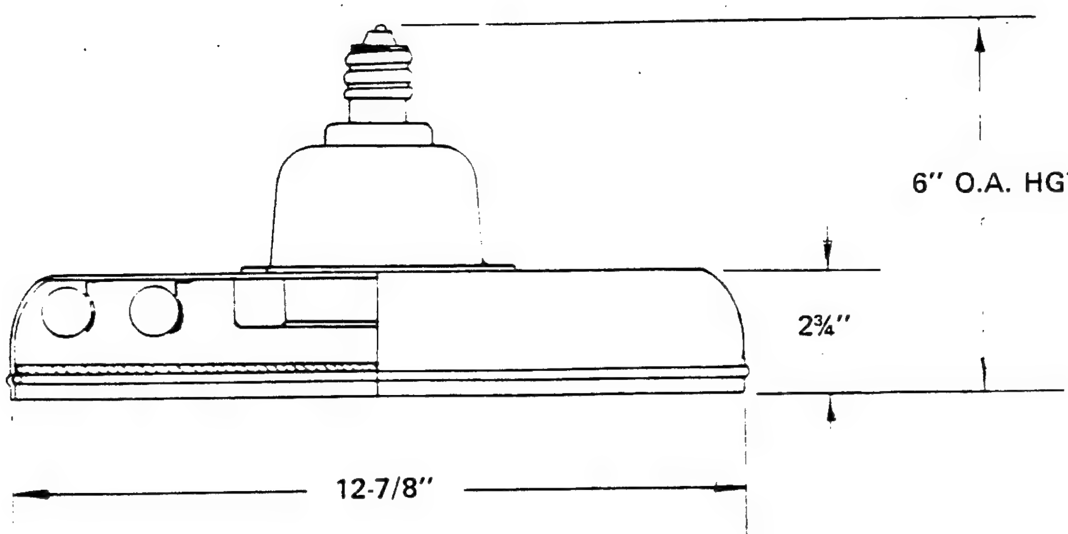
TWIST OF THE WRIST® BRAND ENERGY SAVING LIGHTING FIXTURES

MODEL 23 32 WATT OR 54 WATT

SOCKET: Standard Medium Base **HOUSING:** Aluminum **DIFFUSER:** Clear Polycarbonate

BALLAST: Robertson R32AP-WS (32 watt)
Robertson R2232P-WS (54 watt)

MODEL =	LAMP	WATTAGE	TEMPERATURE RANGE
23-32	FC12T10	32	Down to 32°F
23-54	FC12T10	32	Down to 32°F
	FC8T9	22	
23-32-0'	FC12T10	32	Down to 0°F
23-54-0'	FC12T10	32	Down to 0°F



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E-00284

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ECP ENERGY CONSERVATION PRODUCTS
511 CANAL STREET NEW YORK, N.Y. 10013 (212)925-5991

EFFECTIVE 3/1/84

PRICING - MODEL # 23 SCREW-IN FLUORESCENT CONVERSIONS

FIXTURE PRICES DO NOT INCLUDE LAMPS.

MODEL	DESCRIPTION	LIST	CONT.	MIN QTY
23-32	32 WATT SCREW IN FLUORESCENT FIXTURE (WHITE FINISH) WITH LEXAN DIFFUSER.	85.80	42.90	3
23-54	54 WATT SCREW IN FLUORESCENT FIXTURE (WHITE FINISH) WITH LEXAN DIFFUSER.	99.30	49.65	3
	OPTIONS			
DIFFUSER	N - WITHOUT LEXAN DIFFUSER DEDUCT	9.90	4.95	-
BALLAST	V - 277 VOLT BALLAST	12.00	6.00	
	O - ZERO DEGREE BALLAST(DOWN TO 0 F) 32WATT	16.00	8.00	-
	54WATT	16.00	8.00	-

STANDARD MODEL BALLAST WILL LIGHT DOWN TO 32 F. ORDERS BELOW MINIMUM ADD 10%

PRICING - MODEL #25 RECESSED CEILING FIXTURE RETRO-FIT

FIXTURE PRICES DO NOT INCLUDE LAMP.

MODEL	DESCRIPTION	LIST	CONT.	MIN QTY
25-20-DW	20 WATT RECESSED FLUORESCENT CONVERSION FIXTURE WITH SCREW IN ADAPTOR AND WHITE ACRYLIC DIFFUSER (WHITE FINISH)	91.80	45.90	5
25-22-DW	22 WATT - SAME AS ABOVE	104.00	52.00	100
	OPTIONS			
DIFFUSER	PQ - PARASQUARE	13.40	6.70	-
	PA - PARAHEX	14.90	7.45	-
BODY TYPE	A - ADJUSTABLE STEM	CONSULT FACTORY...		
BALLAST	C - COLD WEATHER BALLAST	14.00	7.00	-

ORDERS BELOW MINIMUM ADD 10%

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT: RAAP Lighting Projects
AEP NO. 290 0379 000
SHEET 1 OF 10
DESIGNER: T. Todd
DATE:
CHECKER:
DATE:

GP-N-3 REPLACE EXTERIOR INCANDESCENTS WITH COMPACT FLUORESCENT FLOODS

Many buildings at RAAP are lit with inefficient incandescent lighting. This ECO analyzes the replacement of exterior incand. floods with 13W PL compact fluorescent flood retrofits which screw into the incandescent sockets. This type of project is suitable for non-explosion proof fixtures in areas where a 20-30% reduction in light level is acceptable. Costs and savings were calculated on a per unit basis as shown on page 2. Only areas operating 3 shifts/day, 5 days/wk were considered. A list of buildings with incandescent lighting was compiled from the building survey data (page 3). It is assumed that 50% of the exterior fixtures on this list are non-explosion proof floods.

Number of fixtures = 0.5 (717) = 359

Energy savings = $836 \frac{kwh}{yr} \times 0.003413 \frac{MBtu}{kwh} \times 359 = 1024 \frac{MBtu}{yr}$

Energy cost savings = $\frac{\$25.30}{yr\text{-}fixture} \times 359$ fixtures = \$9083/yr

Matl & Labor cost savings = $\frac{\$18.63}{yr\text{-}fixt.} \times 359$ = \$6688/yr

Total cost savings = 9083 + 6688 = \$15,771/yr

Project cost = \$66.73/fixture × 359 = \$23,956

(Construction cost = 23,956 / 1.115 = \$21,485)

Simple Payback = \$23,956 / (\$15,771/yr) = 1.5 yr

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT RAAP Lighting Projects
Screening Calcs.
DESIGNER T. Todd
CHECKER

AEP NO. 230 0379 000
SHEET 2 OF 10
DATE
DATE

GP-N-3 Reduce light levels - limited applications to replace exterior 150 W incandescents with 13 W fluorescent screw-in retrofits

- Assume original light levels can be reduced by 20-30%

- Assume non-explosion proof application

$$\text{Energy savings} = (150\ W - 16\ W) \times 24\ \frac{hr}{day} \times 260\ \frac{days}{yr} = 836\ \frac{kwh}{yr}$$

$$\text{Energy cost savings} = 836\ \frac{kwh}{yr} \times \frac{\$0.03026}{kwh} = \frac{\$25.30}{yr}$$

$$\text{Labor \& mat'l cost savings} = \left(\frac{\text{Incand. cost}}{750\ hr} - \frac{\text{fluor. cost}}{10{,}000\ hr}\right) \times 6240\ \frac{hr}{yr}$$

$$= \left[\frac{(\$2.11\ \text{mat'l} + \$1.20\ \text{labor} \times 0.683)}{750\ hr} - \frac{(\$7.88\ \text{mat'l} + \$1.95\ \text{labor} \times 0.683)}{10{,}000\ hr}\right] \times 6240\ \frac{hr}{yr}$$

$$= \frac{\$18.63}{yr}$$

$$\text{Total cost savings} = \frac{\$25.30}{yr} + \frac{\$18.63}{yr} = \frac{\$43.93}{yr}$$

Mat'l cost = \$37.32 for fixture price including lamp (1989 vendor info. Reflect-A-Star flood)

Labor cost = \$1.20 × 1.2 × 0.683 (cost of replacing incand. + 20%)

$$\text{Project cost} = \left[(1.045 \times \$37.32) + (1.2 \times \$0.98)\right] \times 1.661 = \$66.73$$

$$\text{Simple payback} = \frac{\$66.73}{\$43.93/yr} = 1.5\ yr < 10\ yr \Rightarrow \text{recommended}$$

RS&H®

SUBJECT

DESIGNER PFH

CHECKER

AEP NO

SHEET OF

DATE 10/29/90

DATE

QRIP Calc.'s

Current energy costs:

$\frac{150\,W}{lamp} \times \frac{24\,hr}{da} \times 260\,da \div 1000 * 359\,lamps * \$0.3026/kwh =$

$= \$10{,}168/yr.$

Current material & labor costs:

$\frac{cost/lamp}{750\,hr} * 359 * 6240\,\frac{hrs}{yr}$

$\frac{2.11 + 1.2 \times 0.68}{750\,hr} * 359 * 6240 = \$8750/yr$

New energy costs:

$16 * 24 * 260 \div 1000 * 359 * 0.03026 = \$1085/yr.$

New mat'l & labor costs

$\frac{7.88 + 1.95 * 0.68}{10{,}000} * 359 * 6240 = \$2062/yr$

Labor savings

$\left(\frac{1.2 \times 0.68}{750} - \frac{1.95 \times 0.68}{10{,}000}\right) * 359 \times 6240 = \$2140/yr.$

For fluorescents, replace ~~both~~ lamp only.

Radford Army Ammunition Plant
List of Buildings with Incandescent Lighting

Bldg No	Name/Process	Location	Similar	Fixtures/Bldg.	Total Fixtures
1000 -00	Cotton Linter Warehouse	NC, A&B-Line	1	17	17
1606 -00	Open Tank Air Dry	Sol. Recovery, A-Line	10	20	200
1611 -00	Solvent Recovery House	Sol. Recovery, B-Line	27	12	324
3513 -00	C-1 Press & Cutting House	Green, C-Line	3	20	60
4912 -27	SG Curing Hse.- Carpet Rolls	Cast Prop. (Rocket)	10	5	50
4924 -06	Machine and Saw House	Cast Prop. (Rocket)	1	6	6
7106 -04	Dry House #4 (Cure Grain)	1st R P	7	8	56
9334 -15	Blender House	4th Rolled Powder	1	4	4
TOTAL FOR EXTERIOR FIXTURES					717
420 -02	Acid Waste Disposal (C-Line)	Waste Acid	1	8	8
2019 -00	Boiling Tub House	NC, B-Line	3	50	150
2022 -00	Beater House	NC, B-Line	3	40	120
2024 -00	Poacher & Blending House	NC, B-Line	3	30	90
3513 -00	C-1 Press & Cutting House	Green, C-Line	3	50	150
4912 -40	Forced Air Dry House	Pilot B	21	10	210
4912 -11	LG Mold Loading House	Cast Prop. (Rocket)	2	6	12
4912 -03	MK 43 Sawing and Inhibiting	Cast Prop. (Rocket)	1	4	4
4915 -00	Small Grain Mold Assembly	Cast Prop. (Rocket)	1	7	7
4921 -00	Inspect/Clean NG Tanks *	Cast Prop. (Rocket)	1	21	21
4951 -02	TOW Launch Saw House	Pilot B	1	8	8
5008 -01	15 Inch Press House	Pilot A	3	2	6
6304 -00	Paste Blending House	1st R P	1	20	20
7113 -00	Roll House (Rolled Powder)	1st R P (F-Line)	1	130	130
9310 -02	Rolled Powder Building	4th Rolled Powder	2	300	600
TOTAL FOR INTERIOR FIXTURES					1536

RS&H

SUBJECT ______________________ AEP NO ______________

______________________ SHEET ______ OF ______

DESIGNER [initials] DATE ______________

CHECKER ______________________ DATE ______________

Current mat'l costs:

$\frac{2.11}{750} * 359 * 6240 = \$6302/yr$

New mat'l costs:

$\frac{7.88}{10{,}000} * 359 * 6240 = \$1765/yr$

Current labor:

$8750 - 6302 = \$2448/yr$

New labor:

$2062 - 1765 = \$297/yr$

CONSTRUCTION COST ESTIMATE	DATE PREPARED 6/96	SHEET 4 OF 10

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: RADFORD ARMY AMMUNITION PLANT

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE:
- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO. GP-N-3

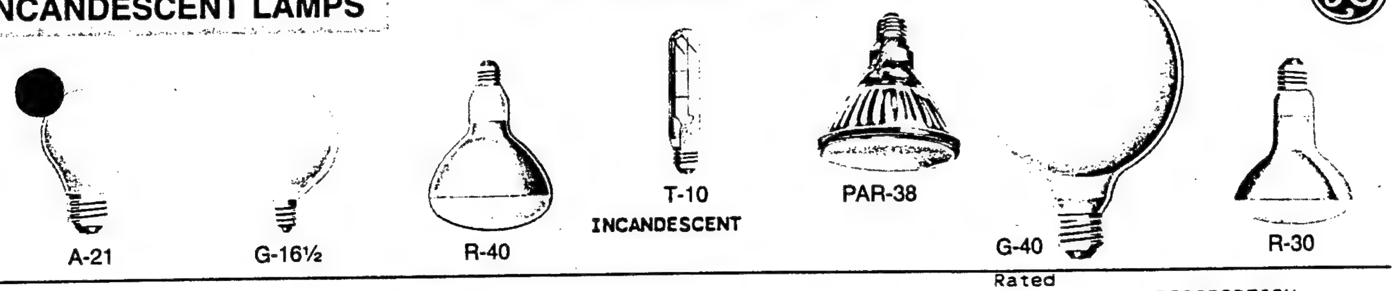
ESTIMATOR: T. Todd

CHECKED BY:

Incand. to fluor. floods SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
Replace incandescent	359	fixt.	0.98	352	37.32	13398	13750
floods with 13W PL							
fluorescent floods							
Sales Tax	4.5%					603	603
FICA/Insurance	20.0%			70			70
Subtotal				422		14001	14423
Overhead	15.0%						2163
Profit	10.0%						1659
Performance Bond	1.0%						182
Hercules Support	6.0%						1106
Contingency	10.0%						1953
Construction Cost							21486

INCANDESCENT LAMPS

GENERAL ELECTRIC LAMPS



Bulb	Base	Prod. Code	Lamp Ordering Code	Volts	Std. Pkg. Qty.	Fila-ment Desgn	MOL (In.)	LCL (In.)	Rated Avg. Life Hours	App. Init Lum.	DESCRIPTION See Incandescent footnotes pg. 46
100 WATTS (Continued)											
G-40	Medium	39627	100G40/W	120	24	CC-6	$6\frac{15}{16}$	--	2500	1280	Pearl (White)--Globe
G-40	Medium	49781	100G40/W 6PK	120	6	CC-6	$6\frac{15}{16}$	--	2500	1280	Pearl (White)--Globe. Moonglow
G-40	Medium	13046	100G40/W/L	120	24	CC-6	$6\frac{15}{16}$	--	4000	1220	Pearl (White)--Globe
A-23	Medium	18599	100A/B	120	120	CC-6	$5\frac{15}{16}$	--	750	--	*Blue
A-23	Medium	18610	100A/G	120	120	CC-6	$5\frac{15}{16}$	--	750	--	*Green
A-23	Medium	18594	100A/O	120	120	CC-6	$5\frac{15}{16}$	--	750	--	*Orange
A-23	Medium	18632	100A/R	120	120	CC-6	$5\frac{15}{16}$	--	750	--	*Red
A-21	Med.(BB)	18363	100A21/TS	120	120	C-9	$4\frac{3}{8}$	$2\frac{7}{16}$	3000	1280	Clear--Traffic Signal. Rated Watts: 98. BDTH (78)
A-21	Med.(BB)	18365	100A21/TS	130	120	C-9	$4\frac{3}{8}$	$2\frac{7}{16}$	3000	1280	" "
A-21	Med.(BB)	18386	100A21/SP	120	120	C-5	$4\frac{3}{8}$	3	200	1340	Clear--Spotlight
A-21	Med.(BB)	17860	100A21/4SP	120	120	C-5	$4\frac{3}{8}$	3	200	--	Light I.F.--Medical Spotlight
A-23	Medium	18449	100A23	120	120	CC-6	$5\frac{15}{16}$	$4\frac{7}{16}$	750	--	Inside Frost
A-23	Med.(BB)	18542	100A23/20	120	120	CC-6	$5\frac{15}{16}$	$4\frac{7}{16}$	1000	--	Clear--Commercial Oven
G-16½	S.C.Bay.	18717	100G16½/29SC	120	60	CC-13	3	$1\frac{3}{8}$	200	1660	Clear--Spotlight. BDTH (7,86,99)
G-16½	D.C.Bay.	18721	100G16½/29DC	120	60	CC-13	3	$1\frac{3}{8}$	200	1660	" "
G-16½	D.C.Bay.	18723	100G16½/29DC	130	60	CC-13	3	$1\frac{3}{8}$	200	1660	"
R-40	Medium	18871	**100R/FL	120	24	CC-6	$6\frac{3}{16}$	--	2000	1190	Reflector Flood. I.F. (4,35,56)
R-	Medium	18873	**100R/FL	130	24	CC-6	$6\frac{3}{16}$	--	2000	1190	"
R-	Medium	18876	100R/SP	120	24	CC-6	$6\frac{3}{16}$	--	2000	1190	Refl. Spot--Light I.F. (4,35,56)
T-8½	Medium	18898	100T8½/9	120	24	CC-13	$5\frac{3}{8}$	3	50	1920	Microscope--ANSI: EDR (22,86,99)
T-10 (HRG)	D.C.Med. Ring	18905	100T10/7	6	24	C-6	5½	$2\frac{3}{16}$	50	--	††Contour Projector ANSI: CPS (1,86,99)
T-10 (HRG)	Med.Pref	18907	100T10P	6	24	C-6	$5\frac{3}{4}$	$2\frac{3}{16}$	50	--	††Contour Projector ANSI: CPT (1,86,99)
A-23	Medium	18512	100A23	12	120	C-6	$5\frac{15}{16}$	$4\frac{7}{16}$	1000	--	Inside Frost (53)
PAR-38 (HRG)	Med.Side Prong	18822	100PAR38/FL	12	12	C-6	$4\frac{5}{16}$	--	1000	1400	PAR--Mine Flood (58)
PAR-38 (HRG)	Med.Skir (BB)	18824	100PAR38/2FL	12	12	C-6	$5\frac{5}{16}$	--	1000	1400	PAR--Flood (14,56,96)
PAR-64 (HRG)	Scr.Term	>39394	100PAR64	6	12	C-6	4	--	50	--	Ceilometer--Very Narrow Spot. Filament shielded
R-30 (HRG)	Med.(BB)	>39503	100R30/CL	12	24	C-6	$5\frac{3}{8}$	--	2000	1200	Reflector Flood--Clear (4,14,53)
T-8	S.C.Bay.	18881	100T8/1SC	20	24	CC-6	3	$2\frac{3}{16}$	50	--	Clear-Contour Map ANSI: BZA (8,31,61,86,94)⊕
A-21	Medium	18290	100A/RS	30	120	C-9	$5\frac{1}{4}$	$3\frac{13}{16}$	1000	--	I.F.--Rough Serv.
A-21	Med.(BB)	17845	100A21/3	32	120	C-5	$4\frac{3}{8}$	3	500	1610	Clear--Locomotive Headlight (13)
A-23	Medium	17904	100A	34	120	C-9	$5\frac{15}{16}$	$4\frac{7}{16}$	1000	2160	I.F.--Train
A-23	Med.(BB)	>17906	100A/BB	34	120	C-9	$5\frac{15}{16}$	$4\frac{7}{16}$	1000	2160	" "
PAR-46 (HRG)	Scr.Term (BB)	34465	100PAR46	60	12	CC-2V	$3\frac{3}{4}$	--	800	--	Mine Locomotive Headlight (71)
A-21	Medium	17976	100A	230	120	C-7A	$5\frac{1}{4}$	$3\frac{13}{16}$	1000	1280	Inside Frost
A-21	Medium	17983	100A	250	120	C-7A	$5\frac{1}{4}$	$3\frac{13}{16}$	1000	1280	" "
A-21	Med.(BB)	18346	100A/99	230-250	120	C-7A	$5\frac{1}{4}$	$3\frac{13}{16}$	2500	--	I.F.--Ext. Serv.
A-21	Medium	18334	100A/RS	250	120	C-17	$5\frac{1}{4}$	$3\frac{13}{16}$	1000	960	I.F.--Rough Serv.

> New product listing.
* In "base up" use, heat eventually may deteriorate paper-lined or plastic sockets.
⊕ Source W x H: 4.5 x 3.0mm. Burn base up.
†† Filament offset .100" +-.030" from base axis.
** FOR ENERGY SAVING in deep down lights consider the 75ER30 lamp shown on page 23 . The resulting cost savings are shown on page 5.

INCANDESCENT LAMPS

GENERAL ELECTRIC LAMPS

PAR-38

INCANDESCENT

R-40

Bulb	Base	Prod. Code	Lamp Ordering Code	Volts	Std. Pkg. Qty.	Fila-ment Desgn	MOL (In.)	LCL (In.)	Rated Avg. Life Hours	App. Init Lum.	DESCRIPTION See Incandescent footnotes pg. 46
150 WATTS (Continued)											
PAR-46 (HRG)	Med.Side Prong	41966	150PAR46/3NSP	125	12	CC-13	4	--	2000	1500	Narrow Spot (11,56,58,96)
PAR-46 (HRG)	Med.Side Prong	41968	150PAR46/3MFL	125	12	CC-13	4	--	2000	1500	Medium Flood (11,56,58,96)
PAR-46 (HRG)	Scr.Term (BB)	19517	150PAR46	125	12	C-13	3 3/4	--	1000	--	Mine Locomotive Headlight
PAR-46 (HRG)	3-Prong	>35327	150PAR46/TS	115	12	CC-6	4	--	6000	--	Traffic Signal Stippled Reflector Tapioca lens cover (2)
PAR-38 (HRG)	Med.Side Prong	44933	150PAR/3VWFL	125	12	C-13	4 5/16	--	2000	--	† Mine--Wide Flood (56,58,96)
PAR-38 (HRG)	Med.Side Prong	19497	150PAR/4	125	12	C-13	4 5/16	--	2000	--	† Mine--Spot (56,58,96)
PAR-38 (HRG)	Med.Skir (BB)	19509	150PAR/5	125	12	C-13	5 5/16	--	2000	--	† Mine--Spot (14,56,96)
PAR-46 (HRG)	Scr.Term (BB)	19518	150PAR46/3	175	12	C-13	3 3/4	--	800	--	Mine. Locomotive Headlight (71)
R-40	Medium	19797	**150R/FL	120	24	CC-6	6 9/16	--	2000	1900	Reflector Flood--ANSI: DWC (4,14,35,56)
R-40	Medium	>16445	150R/FL-1 6PK	120	30	CC-6	6 9/16	--	2000	1900	Standard Reflector Flood (4,14,35,56)
R-40	Medium	19799	**150R/FL	130	24	CC-6	6 9/16	--	2000	1900	Reflector Flood (4,14,35,56)
R-40	Med.(BB)	14715	150R/FL/CVG	130	24	CC-6	6 9/16	--	2000	--	>>Refl. Flood--COV-R-GUARD™ (4,35,56,83)
R-40	Medium	19783	150R/SP	120	24	CC-6	6 9/16	--	2000	1900	Refl. Spot--Light I.F. (4,14,35,56)
R-40	Medium	>16446	150R/SP-1 6PK	120	30	CC-6	6 9/16	--	2000	1900	Standard Reflector Spot (4,14,35,56)
R-40	Medium	19785	150R/SP	130	24	CC-6	6 9/16	--	2000	1900	Reflector Spot--Light I.F. (4,14,35,56)
R-40	Medium	19844	150R/A	120	24	CC-6	6 9/16	--	2000	--	Reflector--Amber (14,35,36)
R-40	Medium	19823	150R/B	120	24	CC-6	6 9/16	--	2000	--	Reflector--Blue (14,35,36)
R-40	Medium	19827	150R/BW	120	24	CC-6	6 9/16	--	2000	--	Reflector--Blue-White (14,35,36)
R-40	Medium	19831	150R/G	120	24	CC-6	6 9/16	--	2000	--	Reflector--Green (14,35,36)
R-40	Medium	19835	150R/PK	120	24	CC-6	6 9/16	--	2000	--	Reflector--Pink (14,35,36)
R-40	Medium	19841	150R/R	120	24	CC-6	6 9/16	--	2000	--	Reflector--Red (14,35,36)
R-40	Medium	19851	150R/Y	120	24	CC-6	6 9/16	--	2000	--	Reflector--Yellow (14,35,36)
R-40	Med.(BB)	41627	150R40/PL 6PK	120	24	CC-6	6 9/16	--	2000	--	Reflector Plant Light--"Gro and Sho" (4,14,56)
R-40	Medium	44674	150R40/TB	120	24	CC-6	6 9/16	--	2000	--	Jewelry Spot Reflector Transparent Daylight Blue (4,14,35,56,76)
R-40	Medium	44675	150R40/TB	130	24	CC-6	6 9/16	--	2000	--	Jewelry Spot Reflector Transparent Daylight Blue (4,14,35,56,76)
P-25	Med.(BB)	19372	150P25/10	120	60	C-5	4 3/4	3	200	2100	Light I.F.--Spotlight. Hard glass button

\> New product listing.
\>> Teflon® Coated. Teflon is a registered trademark of Dupont.
† Operating position horizontal with locating lug up or down, and with lamp supported by bulb rim.
** **FOR ENERGY SAVING in deep down lights consider the 75ER30 lamp shown on page 23 . The resulting cost savings are shown on page 5.**

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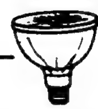
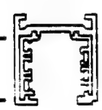
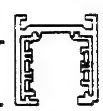
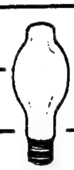
166 100 | Lighting

		166 100 Lighting	CREW	DAILY OUTPUT	MAN-HOURS	UNIT	BARE COSTS MAT.	BARE COSTS LABOR	BARE COSTS EQUIP.	BARE COSTS TOTAL	TOTAL INCL O&P	
140	1600	90 watt	1 Elec	.30	26.670	C	5,140	645		5,785	6,600	140
	1650	135 watt		.20	40		6,905	970		7,875	9,025	
	1700	180 watt		.20	40		7,308	970		8,278	9,475	
	1750	Quartz line, clear, 500 watt		1.10	7.270		1,872	175		2,047	2,325	
	1760	1500 watt		.20	40		3,427	970		4,397	5,200	
	1800	Incandescent, interior, A21, 100 watt		1.60	5		173	120		293	370	
	1900	A21, 150 watt		1.60	5		211	120		331	410	
	2000	A23, 200 watt		1.60	5		227	120		347	430	
	2200	PS 30, 300 watt		1.60	5		330	120		450	540	
	2210	PS 35, 500 watt		1.60	5		576	120		696	810	
	2230	PS 52, 1000 watt		1.30	6.150		1,525	150		1,675	1,900	
	2240	PS 52, 1500 watt		1.30	6.150		2,382	150		2,532	2,850	
	2300	R30, 75 watt		1.30	6.150		375	150		525	630	
	2400	R40, 150 watt		1.30	6.150		408	150		558	670	
	2500	Exterior, PAR 38, 75 watt		1.30	6.150		566	150		716	840	
	2600	PAR 38, 150 watt		1.30	6.150		525	150		675	795	
	2700	PAR 46, 200 watt		1.10	7.270		1,928	175		2,103	2,375	
	2800	PAR 56, 300 watt		1.10	7.270		2,193	175		2,368	2,675	
	3000	Guards, fluorescent lamp, 4' long		1	8		375	195		570	695	
	3200	8' long		.90	8.890		535	215		750	905	
145	0010	RESIDENTIAL FIXTURES										145
	0400	Fluorescent, interior, surface, circline, 32 watt & 40 watt	1 Elec	20	.400	Ea.	48	9.70		57.70	67	
	0500	2' x 2', two U 40 watt		8	1		66	24		90	110	
	0700	Shallow under cabinet, two 20 watt		16	.500		45	12.15		57.15	67	
	0900	Wall mounted, 4'L, one 40 watt, with baffle		10	.800		41	19.40		60.40	74	
	2000	Incandescent, exterior lantern, wall mounted, 60 watt		16	.500		36	12.15		48.15	57	
	2100	Post light, 150W, with 7' post		4	2		104	49		153	185	
	2500	Lamp holder, weatherproof with 150W PAR		16	.500		16	12.15		28.15	35	
	2550	With reflector and guard		12	.667		31	16.15		47.15	58	
	2600	Interior pendent, globe with shade, 150 watt		20	.400		78	9.70		87.70	100	
150	0010	TRACK LIGHTING										150
	0080	Track, 1 circuit, 4' section	1 Elec	6.70	1.190	Ea.	33	29		62	79	
	0100	8' section		5.30	1.510		48	37		85	105	
	0200	12' section		4.40	1.820		81	44		125	155	
	0300	3 circuits, 4' section		6.70	1.190		36	29		65	82	
	0400	8' section		5.30	1.510		48	37		85	105	
	0500	12' section		4.40	1.820		88	44		132	160	
	1000	Feed kit, surface mounting		16	.500		12	12.15		24.15	31	
	1100	End cover		24	.333		1.98	8.10		10.08	14.05	
	1200	Feed kit, stem mounting, 1 circuit		16	.500		16	12.15		28.15	35	
	1300	3 circuit		16	.500		16	12.15		28.15	35	
	2000	Electrical joiner for continuous runs, 1 circuit		32	.250		6.55	6.05		12.60	16.10	
	2100	3 circuit		32	.250		12.10	6.05		18.15	22	
	2200	Fixtures, spotlight, 150 PAR		16	.500		47	12.15		59.15	70	
	3000	Wall washer, 250 watt tungsten halogen		16	.500		101	12.15		113.15	130	
	3100	Low voltage, 25/50 watt, 1 circuit		16	.500		102	12.15		114.15	130	
	3120	3 circuit		16	.500		109	12.15		121.15	140	


166 100 | Lighting

			CREW	DAILY OUTPUT	MAN-HOURS	UNIT	BARE COSTS MAT.	BARE COSTS LABOR	BARE COSTS EQUIP.	BARE COSTS TOTAL	TOTAL INCL O&P	
135	5100	175 watt metal halide	1 Elec	8	1	Ea.	479	24		503	565	135
	5110	250 watt metal halide		8	1		500	24		524	585	
	5120	150 watt high pressure sodium		8	1		535	24		559	625	
	5130	250 watt high pressure sodium		8	1		556	24		580	645	
	5140	72"H 18" sq., 400 watt metal halide		8	1		525	24		549	615	
	5150	250 watt high pressure sodium		8	1		556	24		580	645	
	5160	400 watt high pressure sodium		8	1		581	24		605	675	
	5190	Portable rectangle, 6" high 13.5" x 20"										
	5200	175 watt metal halide	1 Elec	12	.667	Ea.	293	16.15		309.15	345	
	5210	250 watt metal halide		12	.667		314	16.15		330.15	370	
	5220	150 watt high pressure sodium		12	.667		335	16.15		351.15	390	
	5230	250 watt high pressure sodium		12	.667		360	16.15		376.15	420	
	5240	8" high 18" x 24", 400 watt metal halide		12	.667		365	16.15		381.15	425	
	5250	250 watt high pressure sodium		12	.667		376	16.15		392.15	435	
	5260	400 watt high pressure sodium		12	.667		398	16.15		414.15	460	
	5270	Portable square, 15" high 13.5" sq., 175 watt metal halide		12	.667		324	16.15		340.15	380	
	5280	250 watt metal halide		12	.667		376	16.15		392.15	435	
	5290	150 watt high pressure sodium		12	.667		360	16.15		376.15	420	
	5300	250 watt high pressure sodium		12	.667		386	16.15		402.15	450	
	5400	Pendent 16" round/square, 175 watt metal halide		3.20	2.500		355	61		416	480	
	5410	250 watt metal halide		2.70	2.960		370	72		442	515	
	5420	400 watt metal halide		2.40	3.330		398	81		479	555	
	5430	150 watt high pressure sodium		3.20	2.500		398	61		459	525	
	5440	250 watt high pressure sodium		2.70	2.960		428	72		500	575	
	5450	400 watt high pressure sodium		2.40	3.330		454	81		535	620	
140	0010	LAMPS										140
	0080	Fluorescent, rapid start, cool white, 2' long, 20 watt	1 Elec	1	8	C	348	195		543	670	
	0100	4' long, 40 watt		.90	8.890		198	215		413	535	
	0120	3' long, 30 watt		.90	8.890		442	215		657	805	
	0150	U-40 watt		.80	10		874	245		1,119	1,325	
	0170	4' long, 35 watt energy saver		.90	8.890		270	215		485	615	
	0200	Slimline, 4' long, 40 watt		.90	8.890		618	215		833	995	
	0300	8' long, 75 watt		.80	10		577	245		822	990	
	0350	8' long, 60 watt energy saver		.80	10		603	245		848	1,025	
	0400	High output, 4' long, 60 watt		.90	8.890		750	215		965	1,150	
	0500	8' long, 110 watt		.80	10		775	245		1,020	1,200	
	0520	Very high output, 4' long, 110 watt		.90	8.890		1,285	215		1,500	1,725	
	0550	8' long, 215 watt		.70	11.430		1,285	275		1,560	1,825	
	0600	Mercury vapor, mogul base, deluxe white, 100 watt		.30	26.670		2,142	645		2,787	3,300	
	0650	175 watt		.30	26.670		1,663	645		2,308	2,775	
	0700	250 watt		.30	26.670		2,968	645		3,613	4,225	
	0800	400 watt		.30	26.670		2,340	645		2,985	3,525	
	0900	1000 watt		.20	40		5,100	970		6,070	7,025	
	1000	Metal halide, mogul base, 175 watt		.30	26.670		3,749	645		4,394	5,075	
	1100	250 watt		.30	26.670		4,712	645		5,357	6,125	
	1200	400 watt		.30	26.670		4,386	645		5,031	5,775	
	1300	1000 watt		.20	40		9,894	970		10,864	12,300	
	1320	1000 watt, 125,000 initial lumens		.20	40		9,960	970		10,930	12,400	
	1330	1500 watt		.20	40		9,268	970		10,238	11,600	
	1350	Sodium high pressure, 70 watt		.30	26.670		4,712	645		5,357	6,125	
	1360	100 watt		.30	26.670		4,871	645		5,516	6,300	
	1370	150 watt		.30	26.670		5,059	645		5,704	6,525	
	1380	250 watt		.30	26.670		5,380	645		6,025	6,875	
	1400	400 watt		.30	26.670		5,727	645		6,372	7,250	
	1450	1000 watt		.20	40		13,352	970		14,322	16,100	
	1500	Low pressure, 35 watt		.30	26.670		3,963	645		4,608	5,300	
	1550	55 watt		.30	26.670		4,386	645		5,031	5,775	



LUMATECH CONTRACTOR PRICE LIST

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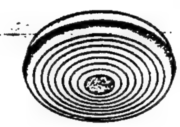
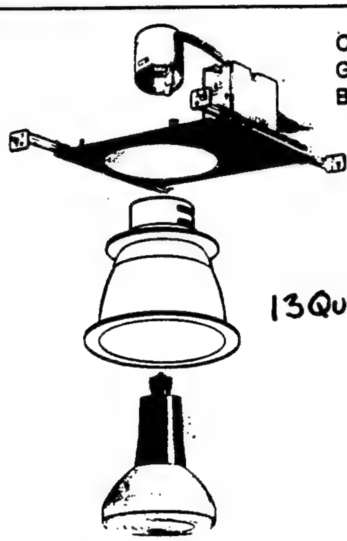
CODE		DESCRIPTION	STD. PKG. QTY.	STD. PKG. WGHT. (LBS.)	LIST PRICE	CONTRACTOR PRICE
REFLECT-A-STAR™—COMPACT FLUORESCENT FLOODLIGHT SERIES						
10513T		PL5 3.75" Diameter Reflector	10	11	64.32	32.16
10514T		PL5 4.50" Diameter Reflector	10	11	64.32	[illegible]
10515T		PL5 5.25" Diameter Reflector	10	11	64.32	[illegible]
10923		PL9Q 3.75" Diameter Reflector	10	11	73.14	[illegible]
10924		PL9Q 4.50" Diameter Reflector	10	11	73.14	[illegible]
10925		PL9Q 5.25" Diameter Reflector	10	11	73.14	[illegible]
11324		PL13Q 4.50" Diameter Reflector	10	11	74.64	[illegible]
11325		PL13Q 5.25" Diameter Reflector	10	11	74.64	37.32
-G		Gold reflector option available in all units ADD:			5.25	2.63
10003-P*		Pink Lens	10	1	4.35	2.18
10003-W		Warmtone Lens	10	1	4.35	2.18
10003-WF		Warmtone Frost Lens	10	1	4.35	2.18
10003-PF		Pink Frost Lens	10	1	4.35	2.18
10003-CF		Clear Frost Lens	10	1	3.00	1.50
10003-C		Clear Lens (Standard)	10	1	3.00	1.50
10003-U		Ultraviolet Filter Insert Disk	10	1	4.35	2.18
XT-125		Socket extender—extends unit 1.25"	25	4	4.95	2.48

*IMPORTANT: To order optional lenses or filters, please specify reflector size. The last digit of the product code number for the Reflect-A-Star Series indicates the reflector diameter. "3" indicates 3¾", "4" indicates 4½" and "5" indicates 5¼".

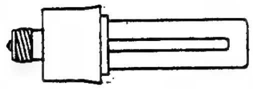
CODE		DESCRIPTION	STD. PKG. QTY.	STD. PKG. WGHT. (LBS.)	LIST PRICE	CONTRACTOR PRICE
RECESSED DOWNLIGHT KIT*						
5111325		Clear Reflector Trim	12	70	176.64	88.32
5121325		Gold Reflector Trim	12	70	176.64	88.32
5131325		Black Reflector Trim	12	70	176.64	103.32

13Quad: 900 lumens as per Bruce Pelton

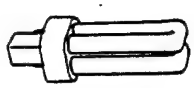
*The recessed downlight kit consists of a frame-in kit, reflector trim in clear, gold or black Alzak® aluminum and a Reflect-A-Star™ model number 11325 with standard reflector and lens.

*Fixture price includes lamp. "PL" or "PLQ" refers to lamp type only. GE, Osram, Philips or Sylvania lamps will be supplied at the discretion of Lumatech. All Reflect-A-Star™ and MicroLamp™ units are Ⓤ and CSA Listed.

MicroLamp™—FLUORESCENT ADAPTOR SERIES

20510		PL5	50	28	28.17	14.09
20710		PL7	50	28	28.17	14.09
20910		PL9	50	28	28.17	14.09
20920		PLQ9	50	28	39.03	19.52
21320		PLQ13	50	30	39.03	19.52

FLUORESCENT REPLACEMENT LAMPS

40510		5W Fluorescent "PL" lamp	50	4	9.00	4.50
40710		7W Fluorescent "PL" lamp	50	4	9.00	4.50
40910		9W Fluorescent "PL" lamp	50	5	9.00	4.50
41310		13W Fluorescent "PL" lamp	50	6	9.75	4.88
40920		9W Fluorescent "PLQ" lamp	50	7	15.75	7.88
41320		13W Fluorescent "PLQ" lamp	50	8	15.75	7.88

CONDITIONS OF SALE

ORDER ACCEPTANCE
Orders are subject to approval at Lumatech corporate headquarters.

PRICES
Prices are subject to change without notice. Lumatech reserves the right to accept and bill all orders at prices in effect at the time of the shipment.

TERMS
Net 30 days on approved credit only. 1½% per month will be assessed on past due invoices. Any account submitted for collection is subject to reasonable attorney fees and costs.

FREIGHT
Transportation costs will be pre-paid and billed F.O.B. Oakland, California.

RETURNS
No merchandise may be returned without prior written authorization. Authorization may be requested within 30 days from the date of original shipment. All returns will be subject to a minimum handling and factory inspection charge of 25% of invoiced amounts, plus freight, except on products considered by Lumatech to be defective in workmanship and materials.

CLAIMS FOR DAMAGE OR LOSS IN SHIPMENT
It is the responsibility of the consignee to file a claim with the transportation company in the event of lost or damaged merchandise. Immediately upon receipt of the shipment, the consignee should check for loss or damage. In the event such has occurred the consignee should file a claim with the transportation company promptly.

CANCELLATIONS
Orders are not cancelable except on payment for all costs incurred, engineering work performed, any materials purchased or commitments made on the part of Lumatech. Lumatech reserves the right to assess a minimum cancellation charge equal to 25% of the original purchase price of the order placed by the customer.

PRODUCT SPECIFICATIONS
Subject to change without notice.

CATALOG ERRORS
Every effort is made on the part of Lumatech Corporation to provide accurate pricing, dimensional and physical description information, etc. in our literature and price lists. However, as this information is subject to change without notice, we cannot accept the responsibility for any loss or damages due to informational errors in our publications. We invite your inquiry regarding up to date information.

MINIMUM ORDER
Minimum net invoice amount is $50.00. Any order under $50.00 is subject to a $10.00 handling charge.

LIMITED WARRANTY
The REFLECT-A-STAR™ and MicroLamp™ series fixtures are warranted to be free from defects in workmanship and materials, as manufactured, for a period of three years from the date of original invoice. Lamps are warranted for 90 days only.

Our invoice covers only replacement or repair at our factory of the defective part(s), to the original purchaser, and excludes any responsibility for labor or freight expense incurred by the purchaser or others, for servicing such claim during the warranty period. Lumatech reserves the right to issue credit, repair or replace defective merchandise, at our option, upon receipt of written notification by the original purchaser of the alleged defect, within the warranty period. Lumatech further reserves the right to examination of the alleged defective product, or proof satisfactory to Lumatech of the defect. This limited warranty is in lieu of all other responsibility for labor costs in connection with the installation, removal or replacement of warranted products, or for any consequential damages. Lumatech further reserves the right to refuse to honor the above warranty for any product(s) altered, improperly installed, or installed in application for which not intended.

For Authorized Dealer Contact:

LUMATECH CORPORATION
5515 Doyle St., Emeryville, CA 94608 (415) 654-4300

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT: RAAP Lighting Projects Screening Calcs.
DESIGNER: T. Todd
CHECKER:

AEP NO: 290 0? 79000
SHEET 1 OF 3
DATE:
DATE:

GP-N-4 GROUP RELAMPING PROJECT:
Replace all 40 W fluorescent lamps with 34 W fluorescents

$$\text{Energy savings} = \frac{6\ \text{W}}{\text{lamp}} \times \frac{24\ \text{hr}}{\text{day}} \times \frac{260\ \text{days}}{\text{yr}} = 37.4\ \frac{\text{kwh}}{\text{yr}} = \frac{0.128\ \text{MMBtu}}{\text{yr}}$$

(assume ballast uses same energy)

$$\text{Cost savings} = 37.4\ \frac{\text{kwh}}{\text{yr}} \times \frac{\$0.03026}{\text{kwh}} = \frac{\$1.13}{\text{yr}}$$

Cost of relamping (198[illegible] Means Electrical):

Mat'l = $2.70 , Labor = $2.15

Adjusted for location [illegible]

Mat'l = 2.70 × 1.002 = 2.71
Labor = 2.15 × 0.683 × 1.2 = 1.76

Construction cost = (1.045 × $2.71 + 1.2 × $1.70) × 1.[illegible]
= $7.45

$$\text{Simple payback} = \frac{\$7.45}{\$1.13/\text{yr}} = 6.6\ \text{yr}$$

$$\text{Life of lamp} = 20{,}000\ \text{hr} \times \frac{\text{yr}}{6240\ \text{hr}} = 3.2\ \text{yr} < 6.6\ \text{yr payback}$$

⇒ Not recommended since life of lamp is less than payback.

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166 100 | Lighting

			CREW	DAILY OUTPUT	MAN-HOURS	UNIT	BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
135	5100	175 watt metal halide	1 Elec	8	1	Ea.	479	24		503	565	135
	5110	250 watt metal halide		8	1		500	24		524	585	
	5120	150 watt high pressure sodium		8	1		535	24		559	625	
	5130	250 watt high pressure sodium		8	1		556	24		580	645	
	5140	72"H 18" sq., 400 watt metal halide		8	1		525	24		549	615	
	5150	250 watt high pressure sodium		8	1		556	24		580	645	
	5160	400 watt high pressure sodium		8	1		581	24		605	675	
	5190	Portable rectangle, 6" high 13.5" x 20"										
	5200	175 watt metal halide	1 Elec	12	.667	Ea.	293	16.15		309.15	345	
	5210	250 watt metal halide		12	.667		314	16.15		330.15	370	
	5220	150 watt high pressure sodium		12	.667		335	16.15		351.15	390	
	5230	250 watt high pressure sodium		12	.667		360	16.15		376.15	420	
	5240	8" high 18" x 24", 400 watt metal halide		12	.667		365	16.15		381.15	425	
	5250	250 watt high pressure sodium		12	.667		376	16.15		392.15	435	
	5260	400 watt high pressure sodium		12	.667		398	16.15		414.15	460	
	5270	Portable square, 15" high 13.5" sq., 175 watt metal halide		12	.667		324	16.15		340.15	380	
	5280	250 watt metal halide		12	.667		376	16.15		392.15	435	
	5290	150 watt high pressure sodium		12	.667		360	16.15		376.15	420	
	5300	250 watt high pressure sodium		12	.667		386	16.15		402.15	450	
	5400	Pendent 16" round/square, 175 watt metal halide		3.20	2.500		355	61		416	480	
	5410	250 watt metal halide		2.70	2.960		370	72		442	515	
	5420	400 watt metal halide		2.40	3.330		398	81		479	555	
	5430	150 watt high pressure sodium		3.20	2.500		398	61		459	525	
	5440	250 watt high pressure sodium		2.70	2.960		428	72		500	575	
	5450	400 watt high pressure sodium		2.40	3.330		454	81		535	620	
140	0010	LAMPS										140
	0080	Fluorescent, rapid start, cool white, 2' long, 20 watt	1 Elec	1	8	C	348	195		543	670	
	0100	4' long, 40 watt		.90	8.890		198	215		413	535	
	0120	3' long, 30 watt		.90	8.890		442	215		657	805	
	0150	U-40 watt		.80	10		874	245		1,119	1,325	
	0170	4' long, 35 watt energy saver		.90	8.890		270	215		485	615	
	0200	Slimline, 4' long, 40 watt		.90	8.890		618	215		833	995	
	0300	8' long, 75 watt		.80	10		577	245		822	990	
	0350	8' long, 60 watt energy saver		.80	10		603	245		848	1,025	
	0400	High output, 4' long, 60 watt		.90	8.890		750	215		965	1,150	
	0500	8' long, 110 watt		.80	10		775	245		1,020	1,200	
	0520	Very high output, 4' long, 110 watt		.90	8.890		1,285	215		1,500	1,725	
	0550	8' long, 215 watt		.70	11.430		1,285	275		1,560	1,825	
	0600	Mercury vapor, mogul base, deluxe white, 100 watt		.30	26.670		2,142	645		2,787	3,300	
	0650	175 watt		.30	26.670		1,663	645		2,308	2,775	
	0700	250 watt		.30	26.670		2,968	645		3,613	4,225	
	0800	400 watt		.30	26.670		2,340	645		2,985	3,525	
	0900	1000 watt		.20	40		5,100	970		6,070	7,025	
	1000	Metal halide, mogul base, 175 watt		.30	26.670		3,749	645		4,394	5,075	
	1100	250 watt		.30	26.670		4,712	645		5,357	6,125	
	1200	400 watt		.30	26.670		4,386	645		5,031	5,775	
	1300	1000 watt		.20	40		9,894	970		10,864	12,300	
	1320	1000 watt, 125,000 initial lumens		.20	40		9,960	970		10,930	12,400	
	1330	1500 watt		.20	40		9,268	970		10,238	11,600	
	1350	Sodium high pressure, 70 watt		.30	26.670		4,712	645		5,357	6,125	
	[illegible]0	100 watt		.30	26.670		4,871	645		5,516	6,300	
	1370	150 watt		.30	26.670		5,059	645		5,704	6,525	
	1380	250 watt		.30	26.670		5,380	645		6,025	6,875	
	1400	400 watt		.30	26.670		5,727	645		6,372	7,250	
	1450	1000 watt		.20	40		13,352	970		14,322	16,100	
	1500	Low pressure, 35 watt		.30	26.670		3,963	645		4,608	5,300	
	1550	55 watt		.30	26.670		4,386	645		5,031	5,775	

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PRODUCT GUIDE

ENERGY-EFFICIENT FLUORESCENT LAMPS

Manufacturer	Lamp	Watts	Mean Lumens	Lumens Per Watt	Lumen Level Compared to Standard Lamp	Color Rendering Index	Color Temperature	Rated Life (Hours)	Electric Cost Savings Per Year	Lamp Cost	Payback
4-FOOT, RAPID-START LAMPS											
General Electric	F40CW Standard	40	2,770	69.3	—	62	4,150	20,000	—	$2.27	—
	F40CW/RS/WM Watt-Miser	34	2,420	71.2	87.4%	62	4,150	20,000	$1.44	$3.14	7.2 months
	F40LW/RS/WMII Watt-Miser II	34	2,575	75.7	93.0%	49	4,200	20,000	$1.44	$3.39	9.3 months
	F40SP41/RS/WMP Watt-Miser Plus	32	2,465	77.0	89.0%	70	4,100	15,000	$1.92	$4.29	12.6 months
	F40BX/SPX41/RS (not a retrofit; see footnote)	40	2,835	70.9	102.3%	82	4,100	20,000	—	$10.28	—
	F32T8/SP41/RS (not a retrofit; see footnote)	32	2,734	85.0	99.0%	75	4,100	20,000	$1.92	$3.66	8.7 months
GTE Sylvania	F40CW Standard	40	2,770	69.3	—	62	4,200	20,000	—	$2.27	—
	F40CW/RS/SS SuperSaver	34	2,440	71.8	81.1%	62	4,200	20,000	$1.44	$3.15	7.3 months
	F40LW/RS/SS SuperSaver	34	2,575	75.7	93%	48	4,150	20,000	$1.44	$3.39	9.3 months
	F40/D41/SS (LWX) Designer SuperSaver	34	2,575	75.7	93%	67	4,100	20,000	$1.44	$4.12	15.4 months
	F40/CW/SSP SuperSaver Plus	32	2,440	76.3	88.1%	62	4,200	20,000	$1.92	3.48	7.6 months
	F40/D41/SSP (LWX) Designer SuperSaver Plus	32	2,575	80.5	93%	67	4,100	20,000	$1.92	$4.42	13.4 months
	FO32 31K/Octron	32	2,600	81.3	93.9%	75	3,100	20,000	$1.92	$3.67	8.7 months
	FO32 41K/Octron	32	2,600	81.3	93.9%	75	4,100	20,000	$1.92	$3.67	8.7 months
N.A. Philips Lighting Corp.	F40CW Cool White Standard	40	2,770	69.3	—	67	4,100	20,000	—	$2.26	—
	F40/41U Ultralume Trichromatic Standard	40	2,935	73.4	106%	85	4,100	20,000	—	$6.95	—
	F40/SPEC41 SPEC 41 Standard	40	2,920	73.0	105%	70	4,100	20,000	—	$3.40	—
	F40AX41 Advantage X Trichromatic Standard	40	3,250	81.3	117%	80	4,100	24,000	—	$9.22	—
	F40T10/LW-SB/99 Lite White Extended Service	40	2,720	68.0	98.2%	51	4,100	24,000	—	$5.79	—
	F40CW/RS/EW-II Cool White Econ-O-Watt	34	2,460	72.4	88.9%	67	4,100	20,000	$1.44	$3.13	7.3 months
	F40/41U/RS/EW-II Ultralume Econ-O-Watt	34	2,650	77.9	95.7%	85	4,100	20,000	$1.44	$7.17	1.8 months
	F40/SPEC41/RW/EW-II SPEC 41 Econ-O-Watt	34	2,615	76.9	94.4%	70	4,100	20,000	$1.44	$3.99	4.9 months
	F40/LW/RS/EW-II Lite White Econ-O-Watt	34	2,620	77.0	94.6%	51	4,100	20,000	$1.44	$3.38	9.3 months
	FO32/30 Octolume (Not a retrofit— see footnote)	32	2,650	77.9	95.7%	85	4,100	20,000	$1.44	$3.65	11.6 months
	FO32/41 Octolume (Not a retrofit— see footnote)	32	2,650	77.9	95.7%	85	4,100	20,000	$1.44	$3.65	11.6 months
8-FOOT, SLIMLINE LAMPS											
General Electric	F96T12/CW Standard	75	5,800	77.3	—	62	4,150	12,000	—	$5.76	—
	F96T12/CW/WM Watt-Miser	60	5,150	85.8	88.8%	62	4,150	12,000	$3.60	$6.66	3 months
	F96T12/LW/WMII Watt-Miser II	60	5,520	92.0	95.2%	49	4,200	12,000	$3.60	$7.12	4.5 months
	F96T12/SP41/WM Watt-Miser	60	5,275	87.9	90.9%	70	4,100	12,000	$3.60	$8.37	8.7 months
GTE Sylvania	F96T12/CW/Standard	75	5,800	77.3	—	62	4,200	12,000	—	$5.59	—
	F96T12/CW/SS SuperSaver	60	5,060	84.3	87.2%	62	4,200	12,000	$3.60	$6.67	3.6 months
	F96T12/LW/SS SuperSaver	60	5,380	89.7	92.8%	48	4,150	12,000	$3.60	$7.12	5.1 months
	F96T12/D41/SS (LWX) Designer SuperSaver	60	5,380	89.7	92.8%	67	4,100	12,000	$3.60	$8.62	10.1 months
N.A. Philips Lighting Corp.	F96T12/CW Cool White Standard	75	5,800	77.3	—	67	4,100	12,000	—	$5.75	—
	F96T12/41U Ultralume Trichromatic Standard	75	5,875	78.3	101.3%	85	4,100	12,000	—	$13.76	—
	F96T12/SPEC 41 Standard	75	5,820	77.6	100.3%	70	4,100	12,000	—	$8.72	—
	F96T12/CW/EW Cool White Econ-O-Watt	60	5,150	85.8	88.7%	67	4,100	12,000	$3.60	$6.66	3.03 months
	F96T12/41U/EW Ultralume Econ-O-Watt	60	5,345	89.1	92.2%	85	4,100	12,000	$3.60	$13.17	immediately
	F96T12/SPEC41/EW SPEC 41 Econ-O-Watt	60	5,335	88.9	92.0%	70	4,100	12,000	$3.60	$8.36	immediately
	F96T12/LW/EW Lite White Econ-O-Watt	60	5,380	89.7	92.8%	51	4,100	12,000	$3.60	$8.37	8.7 months
8-FOOT, HIGH-OUTPUT LAMPS											
General Electric	F96T12/CW/HO Standard	110	8,005	72.8	—	62	4,150	12,000	—	$6.74	—
	F96T12/CW/WM Watt-Miser	95	7,220	76.0	90.2%	62	4,150	12,000	$3.60	$6.96	0.7 months
	F96T12/LW/WMII Watt-Miser II	95	7,655	80.6	95.6%	49	4,200	12,000	$3.60	$7.53	2.7 months
	F96T12/SP41/WM Watt-Miser	95	7,840	82.5	97.9%	70	4,100	12,000	$3.60	$8.81	6.9 months
GTE Sylvania	F96T12/CW/Standard	110	8,000	72.8	—	62	4,200	12,000	—	$6.95	—
	F96T12/CW/SS SuperSaver	95	7,220	76.0	90.3%	62	4,200	12,000	$3.60	$7.17	22 days
	F96T12/LW/SS SuperSaver	95	7,655	80.6	95.7%	48	4,150	12,000	$3.60	$7.78	2.8 months
	F96T12/D41/SS (LWX) Designer SuperSaver	95	7,655	80.6	95.7%	67	4,100	12,000	$3.60	$8.84	6.3 months
N.A. Philips Lighting Corp.	F96T12/CW/HO Cool White Standard	110	8,005	72.8	—	67	4,150	12,000	—	$6.73	—
	F96T12/41U/HO Ultralume Trichromatic Standard	110	8,180	74.4	102.2%	85	4,100	12,000	—	$17.76	—
	F96T12/SPEC41/HO SPEC 41 Standard	110	8,160	74.2	101.9%	70	4,100	12,000	—	$9.28	—
	F96T12/CW/HO/EW Cool White Econ-O-Watt	95	7,220	76.0	90.3%	67	4,100	12,000	$3.60	$6.95	0.7 months
	F96T12/41U/HO/EW Ultralume Econ-O-Watt	95	7,780	81.9	97.2%	85	4,100	12,000	$3.60	$17.31	immediately
	F96T12/SPEC 41/HO/EW SPEC 41 Econ-O-Watt	95	7,650	80.5	95.6%	70	4,100	12,000	$3.60	$8.80	immediately
	F96T12/LW/HO/EW Lite White Econ-O-Watt	95	7,660	80.6	95.7%	51	4,100	12,000	$3.60	$7.54	2.7 months
8-FOOT, ULTRA-HIGH-OUTPUT LAMPS											
General Electric	F96T12/CW/1500 Standard	215	11,050	51.4	—	62	4,150	—	$12.59	—	
	F96T12/CW/1500/WM Watt-Miser	185	10,140	54.8	91.8%	62	4,150	9,000	$7.20	$12.96	.6 months
	F96T12/LW/1500/WMII Watt-Miser II	185	10,765	58.2	97.4%	49	4,200	9,000	$7.20	$18.49	9.8 months
	F96PG17/CW Power Groove STD	215	12,160	68.6	110.0%	62	4,150	12,000	—	$14.44	—
	F96PG17/CW/WM PG Watt-Miser	185	10,360	56.0	93.8%	62	4,150	12,000	$7.20	$15.55	1.5 months
	F96PG17/LW/WMII PG Watt-Miser	185	11,025	59.6	99.8%	49	4,200	12,000	$7.20	$19.28	8.1 months
GTE Sylvania	F96T12/CW/VHO Standard	215	11,050	53.5	—	62	4,200	10,000	—	$12.96	—
	F96T12/CW/VHO/SS Super Saver	195	10,740	55.1	93.4%	62	4,200	10,000	$4.80	$13.35	30 days
	F96T12/LW/VHO/SS Lite White Super Saver	195	11,400	58.5	99.1%	48	4,150	10,000	4.80	$19.24	15.7 months
Philips Lighting Co.	F96T12/CW/VHO Cool White Standard	215	11,500	53.5	—	67	4,100	12,000	—	$14.79	—
	F96T12/CW/VHO/EW Cool White Econ-O-Watt	185	10,780	58.2	93.7%	67	4,100	12,000	$7.20	$12.95	immediately
	F96T12/LW/VHO/EW Lite White Econ-O-Watt	185	11,400	61.6	99.1%	51	4,100	12,000	$7.20	$18.27	5.8 months

General Electric Co., Lighting Business Group, Cleveland, Ohio 44112. Company recommends any standard or energy-efficient magnetic ballast with a high power factor. Operation on low power factor ballasts, dimming and emergency lighting systems (unless approved by the system manufacturer) or operation on reduced current/reduced light output ballasts is not recommended for energy-saving lamps. F4OBX (BIAX) for use with RS ballasts designed for this lamp.

All statistics based on Cool White or equivalent Light White phosphors. F32T lamps for use with RS ballasts designed for this lamp.

GTE Products Corp., Sylvania Lighting Center, Danvers, Mass. 01923. Company recommends any ANSI-approved standard or energy-saving ballast. Octron lamps (1-inch diameter— type T8) are for use with T32T8 Rapid Start ballast (magnetic or electronic) only.

North American Philips Lighting Corp., 200 Franklin Square Drive, Somerset, N.Y. 08873. Econ-O-Watt lamps are only recommended for use on high-power-factor, lead indoor ballasts that meet ANSI standards. The lamps are not recommended for use in drafty areas, or locations where the temperature is less than 60 degrees F. Also, they should not be operated on normal power factor ballasts, reduced light or reduced current ballasts, dimming ballasts or emergency system inverter ballasts. FO32 Octolume lamps are operated on Rapid Start ballasts for 32-watt, T8 sources.

In applications for all energy-efficient lamps, the ambient temperature must be at least 60 degrees. Efficiency figures above do not include energy consumed or lost by the ballast.

The "Mean Lumens" column lists the mean (maintained) lumens emitted by the lamp at 40 percent of its rated lift. The "Lumens Per Watt" column uses the mean lumens to figure the lamp's efficiency.

The closer to 100 the "Color Rendering Index" (CRI), the closer it is to reproducing colors accurately, as by sunlight. The "Color Temperature" (Kelvins) should match other lamps in the room; incandescent lamps are about 2,900 Kelvins and natural sunlight is about 5,500 to 6,500 Kelvins.

Rated life of the lamps listed above is based on 3-hour burning cycles.

The "Electric Cost Per Year" and "Payback" are both based on 3,000 hours of lamp operation per year and an electricity rate of 8 cents per kilowatt hour (Kwh). The "Payback" listed above is based on the cost premium of the energy-efficient lamp over the standard lamp.

The prices of the above lamps are suggested list prices to the end user for a single lamp. Discounts are usually available with quantity purchases.

The above listing is a representative sample from a range of manufacturers. Space limitations prevent all companies and models from being listed. EUN takes no responsibility for misapplication of products, since data is based on manufacturers' statements.

Occupancy sensors and heat pumps will be featured in upcoming Product Guides. Manufacturers are encouraged to send model information including prices to Product Guide Editor, Energy User News, 7 East 12th St., New York, N.Y. 10003; or to call (212) 741-4465.

GP-N-5

Ballast replacement and group relamping project

- Replace standard 40W lamps with 34 W watt-miser plus lamps, and replace standard ballasts with Watt-miser ballasts. Light level will be 90% of original.
- Assume 24 hr/day, 5 day/week operation
- Calculations are for 2-lamp, 1-ballast fixtures.

$$\text{Energy savings} = \left(\frac{181 - 127\ W}{2}\right) \times 24\,\frac{hr}{day} \times 260\,\frac{days}{yr} = 168.5\,\frac{kwh}{yr}$$

$$\text{Cost savings} = 168.5\,\frac{kwh}{yr} \times \frac{\$0.03026}{kwh} = \frac{\$5.10}{yr}$$

$$\text{Matl} = 2(\$2.70) \times 1.002 + \$23.04 = \$28.45$$

$$\text{Labor} = [2(\$2.15) + \$21] \times \underset{\text{location}}{0.683} \times \underset{\text{exp-proof}}{1.2} = \$20.74$$

$$\text{Construction cost} = \left[(1.045 \times \$28.45) + (1.2 \times \$20.74)\right] \times 1.507$$

$$= \$82.31$$

$$\text{Simple payback} = \frac{\$82.31}{\$5.10/yr} = 16.1\ yr > 10\ yr$$

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THE NEW AGE OF 4-FOOT FLUORESCENT LIGHTING

—THE COMBINATIONS—

LAMPS	BALLASTS: STANDARD	WATT-MISER™	MAXI-MISER™	OPTIMISER	PERFORMANCE™ (ELECTRONIC)
STANDARD	Low efficiency High watts UNECONOMICAL Watts = 181 Light = 100%	Good efficiency Moderate watts Watts = 163 Light = 100%	Good efficiency High light output Watts = 168 Light = 104%	High efficiency Low watts Watts = 135 Light = 92%	U.L. listed, however FE-MM is recommended. Watts = NA Light = NA
WATT-MISER®	Moderate efficiency Moderate watts Watts = 159 Light = 91%	Very good efficiency Low watts Watts = 140 Light = 90%	Very good efficiency Good light output Watts = 150 Light = 97%	Very high efficiency Lowest watts LOWEST OP COST Watts = 116 Light = 84%	Not recommended Use FE-WM
WATT-MISER® PLUS	Good Efficiency Low watts Watts = 144 Light = 91%	High efficiency Very low watts LOWEST OWN & OP COST Watts = 127 Light = 90%	High efficiency Low watts Watts = 137 Light = 97%	Not recommended	Not recommended Use FE-WM
MAXI-MISER™	Moderate efficiency High light output Watts = 186 Light = 106%	Good efficiency High light output LOWEST COST OF LIGHT Watts = 167 Light = 106%	Very good efficiency Highest light output LOWEST COST OF LIGHT Watts = 173 Light = 111%	High efficiency Good light output LOWEST COST OF LIGHT Watts = 140 Light = 98%	Not recommended Use FE-MM
OPTIMISER	NO	NO	NO	Very high efficiency Very low watts LOWEST OP COST Watts = 120 Light = 88%	NO
E-TYPE WATT-MISER®	NO	NO	NO	NO	Highest efficiency* Lowest watts LOWEST OP COST Watts = 117 Light = 90%
E-TYPE MAXI-MISER™	NO	NO	NO	NO	Highest efficiency* High light output Watts = 134 Light = 101%

NOTE: Applies to performance in 4-lamp 2 × 4 recessed prismatic troffers, energy cost of 8¢/KWH and 3000 burning hours per year. Light values are based on mean lumens of SP35 lamps. Conclusions shown in CAPS assume typical costs and can vary—especially with energy rates. Where more than one combination is shown as "LOWEST..." their costs are nearly equal and significantly lower than the rest. "LOWEST OWN & OP" and "LOWEST OP COST" are costs per fixture; "LOWEST COST OF LIGHT" is total cost per unit of light.

* The Performance system will typically be LOWEST COST OF LIGHT at higher energy rates and longer burning hours.

(OVER)

GENERAL ELECTRIC

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YOUR BEST SOURCE FOR BALLASTS AND ENERGY SYSTEMS

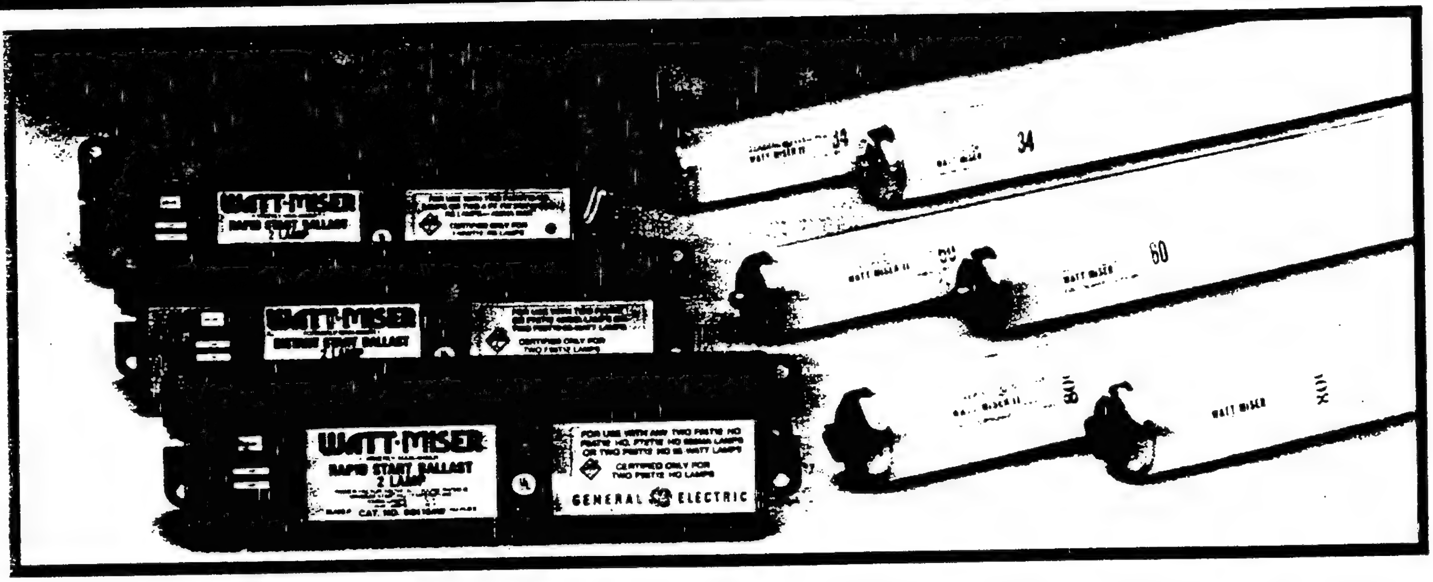
General Electric Ballasts and Energy Systems are available locally from your authorized General Electric stocking distributor. To serve your lighting needs, most distributors can provide you "off-the-shelf" delivery of the most popular ballasts used today. Select the ballast or system right for your application—then contact your GE distributor for prompt and courteous service. **Quick Reference Guide to the Most Popular Standard & Energy Saving Ballasts**

FOR FLUORESCENT LAMPS

Product Code	Catalog Number	Line Volts	Pkg. Qty.	Ballast Type	Lamps Operated by Ballasts Number & Type
	PERFORMANCE™ ELECTRONIC BALLASTS				
14868	E40-120-2	120	20	PERFORMANCE	(2) FE40/WM or (2) FE40/MM or
14869	E40-277-2	277	20	PERFORMANCE	(2) F40T12/RS
14870	E40-120-3	120	20	PERFORMANCE	(3) FE40/WM or (3) FE40/MM or
14871	E40-277-3	277	20	PERFORMANCE	(3) F40T12/RS
	T8 RAPID START				
16764	8G4126W18	120	20	T-8 WATT-MISER™	(2) F32T8RS or
16767	8G4136W18	277	20	T-8 WATT-MISER™	(2)F25T8RS
	ELECTRO-MAGNETIC BALLASTS–F30 RAPID START				
14282	M28-120F+	120	10	OPTIMISER	(2)
46067	8G3971WF	120	10	Standard	F30 Rapid Start
46035	8G3905WF*	120	10	Low-Temp.	Standard
14283	M28-277F+	277	10	OPTIMISER	or
46070	8G3972WF	277	10	Standard	WATT-MISER*
	F40 RAPID START				
14284	M28-120-1F	120	10	OPTIMISER	(1)
48582	8G1078WF	120	10	MAXI-MISER™ II	F40 Rapid Start
48571	8G1074WF	120	10	WATT-MISER	Standard
45686	•8G1063WF	120	10	Standard	or
46075	8G5001WF*	120	10	Dimming	WATT-MISER
45900	8G3688WF*	120	10	Low Temp.	or
45210	8G1075F*	120	10	Low Power Factor	F40 MAXI-MISER
14285	M28-277-1F	277	10	OPTIMISER	
48589	8G1088WF	277	10	MAXI-MISER II	
48585	8G1084WF	277	10	WATT-MISER	
45709	•8G1068WF	277	10	Standard	
14282	M28-120F++	120	10	OPTIMISER	(2)
45204	8G1028WF++	120	10	MAXI-MISER II	F40 Rapid Start
45203	8G1024WF	120	10	WATT-MISER	Standard
45201	•8G1022WF	120	10	Standard	or
46035	8G3905WF*	120	10	*Low Temp.	WATT-MISER
46077	8G5007WF*	120	10	Dimming	or
14283	M28-277F++	277	10	OPTIMISER	F40 MAXI-MISER
45208	8G1038WF++	277	10	MAXI-MISER II	
45207	8G1034WF	277	10	WATT-MISER	
45206	•8G1032WF	277	10	Standard	
14277	8G1324W**	120	20	WATT-MISER	(3)
14279	8G1334W**	277	20	WATT-MISER	F40 WATT-MISER
	INSTANT START				
45221	8G1600WF	120	6	Standard	(2)
45789	8G1628WF*	120	6	Low Temp.	F48T12, F40/IS,
45812	8G1710WF	277	6	Standard	F40T17/IS or
45791	8G1631WF*	277	6	Low Temp.	WATT-MISERS
45213	8G1008WF	120	6	MAXI-MISER II	(2)
45212	8G1004WF	120	6		F96/84/72T12
45215	•8G1011WF	120	6	Standard	Instant Start
45779	8G1490WF*	120	6	Low Temp.	or
45219	8G1018WF	277	6	MAXI-MISER II	WATT-MISERS
45216	8G1014WF	277	6	WATT-MISER	
45218	•8G1015WF	277	6	STD.-6 Leads	
46954	•8G1899WF	277	6	STD.-4 Leads	
45818	8G1762WF	120	6	Standard-0°F	(1) F96/84/72T12
45821	8G1764WF	277	6	Standard-0°F	Instant Start
	HIGH OUTPUT 800m.a.				
46966	8G3885WF	120	6	Standard	(2)
46030	8G3900WF	120	6	Low Temp.	F48T12/HO or
46020	8G3887WF	277	6	Standard	WATT-MISERS

•Not approved for installation in the state of New York or California.
+ U.L. listed only for reduced wattage, F30T12 lamps.
* Not recommended for use with Watt-Miser and other reduced wattage type fluorescent lamps.
++ Not recommended for use with Watt-Miser U-shaped lamps.
** U.L. listed only for Watt-Miser and other reduced wattage lamps.

GE WATT-MISER™ BALLASTS USE LESS WATTS PER FIXTURE TO DELIVER HIGH ENERGY SAVINGS



Watt-Miser Ballasts

- Compatible with standard or energy-saving lamps (3-lamp WM ballast compatible only with ES lamps)
- Cooler operation extends ballast life
- Dimensionally interchangeable with standard ballasts.
- CBM-certified by ETL with standard lamps. (3-lamp WM ballast not CBM certified)
- UL-listed, Class P.

The GE Watt-Miser ballast is inherently more energy-efficient than a standard ballast. Even greater savings come from pairing Watt-Miser ballasts with today's popular reduced-wattage lamps. Watt-Miser ballasts are offered for 4′ Rapid Start; 8′ Instant Start; and 8′ High Output applications. A 3-lamp Watt-Miser ballast in a standard rapid start case is available for use with four-foot energy-saving lamps. The chart shows fixture watts and energy $ that can be saved by replacing standard lamps and ballasts with Watt-Miser ballasts and energy-saving lamps.

Lamp/Ballast System Replacement Chart

Fluorescent Fixture Type	Standard System(1)		Watt-Miser System			
	Lamp Type	Watts Per Fixture	Lamp Type(2)	Watt-Miser Ballast(4)	Watts Saved Per Fixture	Energy(3) $ Saved Per Fixture
4-LAMP TROFFER	F40 F40 (34W)	181 159	F40LW/RS/WMII F40LW/RS/WMII	(2)8G1024W (2)8G1024W	41 19	$ 9.84 $ 4.56
3-LAMP TROFFER	F40	149	F40LW/RS/WMII	(1)8G1024W and (1)8G1074W (1)8G1324W	40 43	$ 9.60 $10.32
2-LAMP INDUSTRIAL	F40 F96T12 F96T12/HO	96 172 255	F40LW/RS/WMII F96T12/LW/WMII F96T12/LW/HO/WMII	8G1024W 8G1004W 8G1154W	25 46 56	$ 6.00 $16.56 $20.16
2-LAMP, SURFACE-MOUNT, WRAP AROUND	F40	82	F40LW/RS/WMII	8G1024W	16	$ 3.36
4-LAMP, SURFACE-MOUNT, WRAP AROUND	F40	165	F40LW/RS/WMII	(2)8G1024W	32	$ 6.72

(1) Fixture equipped with standard ballast and lamp shown.
(2) Other energy-saving lamps may be used to obtain similar savings.
(3) Annual energy savings at 8¢ KWH; 3000 Hrs.—F40; 4500 Hrs.—F96.
(4) Ballast codes shown are 120-volt. For complete application information, see product tables.

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166 100 | Lighting

		166 100 Lighting	CREW	DAILY OUTPUT	MAN-HOURS	UNIT	BARE COSTS MAT.	BARE COSTS LABOR	BARE COSTS EQUIP.	BARE COSTS TOTAL	TOTAL INCL O&P	
135	5100	175 watt metal halide	1 Elec	8	1	Ea.	479	24		503	565	135
	5110	250 watt metal halide		8	1		500	24		524	585	
	5120	150 watt high pressure sodium		8	1		535	24		559	625	
	5130	250 watt high pressure sodium		8	1		556	24		580	645	
	5140	72"H 18" sq., 400 watt metal halide		8	1		525	24		549	615	
	5150	250 watt high pressure sodium		8	1		556	24		580	645	
	5160	400 watt high pressure sodium		8	1		581	24		605	675	
	5190	Portable rectangle, 6" high 13.5" x 20"										
	5200	175 watt metal halide	1 Elec	12	.667	Ea.	293	16.15		309.15	345	
	5210	250 watt metal halide		12	.667		314	16.15		330.15	370	
	5220	150 watt high pressure sodium		12	.667		335	16.15		351.15	390	
	5230	250 watt high pressure sodium		12	.667		360	16.15		376.15	420	
	5240	8" high 18" x 24", 400 watt metal halide		12	.667		365	16.15		381.15	425	
	5250	250 watt high pressure sodium		12	.667		376	16.15		392.15	435	
	5260	400 watt high pressure sodium		12	.667		398	16.15		414.15	460	
	5270	Portable square, 15" high 13.5" sq., 175 watt metal halide		12	.667		324	16.15		340.15	380	
	5280	250 watt metal halide		12	.667		376	16.15		392.15	435	
	5290	150 watt high pressure sodium		12	.667		360	16.15		376.15	420	
	5300	250 watt high pressure sodium		12	.667		386	16.15		402.15	450	
	5400	Pendent 16" round/square, 175 watt metal halide		3.20	2.500		355	61		416	~~480~~	
	5410	250 watt metal halide		2.70	2.960		370	72		442	515	
	5420	400 watt metal halide		2.40	3.330		398	81		479	555	
	5430	150 watt high pressure sodium		3.20	2.500		398	61		459	525	
	5440	250 watt high pressure sodium		2.70	2.960		428	72		500	575	
	5450	400 watt high pressure sodium		2.40	3.330		454	81		535	620	
140	0010	LAMPS										140
	0080	Fluorescent, rapid start, cool white, 2' long, 20 watt	1 Elec	1	8	C	348	195		543	670	
	0100	4' long, 40 watt		.90	8.890		198	215		413	535	
	0120	3' long, 30 watt		.90	8.890		442	215		657	805	
	0150	U-40 watt		.80	10		874	245		1,119	1,325	
	0170	4' long, 35 watt energy saver		.90	8.890		270	215		485	615	
	0200	Slimline, 4' long, 40 watt		.90	8.890		618	215		833	995	
	0300	8' long, 75 watt		.80	10		577	245		822	990	
	0350	8' long, 60 watt energy saver		.80	10		603	245		848	1,025	
	0400	High output, 4' long, 60 watt		.90	8.890		750	215		965	1,150	
	0500	8' long, 110 watt		.80	10		775	245		1,020	1,200	
	0520	Very high output, 4' long, 110 watt		.90	8.890		1,285	215		1,500	1,725	
	0550	8' long, 215 watt		.70	11.430		1,285	275		1,560	1,825	
	0600	Mercury vapor, mogul base, deluxe white, 100 watt		.30	26.670		2,142	645		2,787	3,300	
	0650	175 watt		.30	26.670		1,663	645		2,308	2,775	
	0700	250 watt		.30	26.670		2,968	645		3,613	4,225	
	0800	400 watt		.30	26.670		2,340	645		2,985	3,525	
	0900	1000 watt		.20	40		5,100	970		6,070	7,025	
	1000	Metal halide, mogul base, 175 watt		.30	26.670		3,749	645		4,394	5,075	
	1100	250 watt		.30	26.670		4,712	645		5,357	6,125	
	1200	400 watt		.30	26.670		4,386	645		5,031	5,775	
	1300	1000 watt		.20	40		9,894	970		10,864	12,300	
	1320	1000 watt, 125,000 initial lumens		.20	40		9,960	970		10,930	12,400	
	1330	1500 watt		.20	40		9,268	970		10,238	11,600	
	1350	Sodium high pressure, 70 watt		.30	26.670		4,712	645		5,357	6,125	
	1360	100 watt		.30	26.670		4,871	645		5,516	6,300	
	1370	150 watt		.30	26.670		5,059	645		5,704	6,525	
	1380	250 watt		.30	26.670		5,380	645		6,025	6,875	
	1400	400 watt		.30	26.670		5,727	645		6,372	7,250	
	1450	1000 watt		.20	40		13,352	970		14,322	16,100	
	1500	Low pressure, 35 watt		.30	26.670		3,963	645		4,608	5,300	
	1550	55 watt		.30	26.670		4,386	645		5,031	5,775	

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Project No. 87-210-08
PTAC No. 865911

Telephone Call Confirmation

reynolds, smith and hills

Local 396-7446 L.D. (813) Tampa 988-7351 Placed ✓ Rec'd ______ Date 5-22-87

T. Masters Conversed with Stan Jefson / Joe Howley

Of G.E. Lamp Marketing / Engineering Regarding ballasts

Stan Jefson provided costs, Joe Howley provided wattages, light output, lifetimes

4 ft			Cost	Life (function of heat)
Standard	8G1022WF	(S)	$15.86	10-12 yr
Wattmiser	8G1024WF	(W)	$21.94	24 yr
Maximiser II	8G1028WF	(M)	$22.89	24 yr
Optimiser	M28-120F	(O)	$34.10	30 yr

energy-efficient

- Maximiser II - patented, full light output using energy saving lamps, may be able to delamp with this one
- Optimiser - patented, newest, lowest wattage input

8 ft				
Standard	8G1011WF	(S)	$25.90	12 yr
Wattmiser	8G1004WF	(W)	$36.86	24 yr
Maximiser II	8G1008WF	(M)	$39.17	24 yr

Distribution:

4

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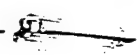
166 100 | Lighting

		CREW	DAILY OUTPUT	MAN-HOURS	UNIT	BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
6020	Recessed, 200 watt	1 Elec	6.70	1.190	Ea.	51	29		80	99	130
6030	Pendent, 200 watt		6.70	1.190		43	29		72	90	
6040	Wall, 200 watt		8	1		44	24		68	84	
6100	Fluorescent, surface mounted, 2 lamps, 4'L, RS, 40 watt		3.20	2.500		70	61		131	165	
6110	Industrial, 2 lamps 4' long in tandem, 430 MA		2.20	3.640		139	88		227	280	
6130	2 lamps 4' long, 800 MA		1.90	4.210		100	100		200	260	
6160	Pendent, indust, 2 lamps 4'L in tandem, 430 MA		1.90	4.210		149	100		249	315	
6170	2 lamps 4' long, 430 MA 		2.30	3.480		80	84		164	210	
6180	2 lamps 4' long, 800 MA		1.70	4.710		109	115		224	290	
6200	Mercury vapor with ballast, 175 watt		3.20	2.500		226	61		287	340	
6300	Explosionproof										
6310	Metal halide, ballast, ceiling, surface mounted, 175 watt	1 Elec	2.90	2.760	Ea.	668	67		735	835	
6320	250 watt		2.70	2.960		775	72		847	960	
6330	400 watt		2.40	3.330		836	81		917	1,050	
6340	Ceiling, pendent mounted, 175 watt		2.60	3.080		640	75		715	815	
6350	250 watt		2.40	3.330		745	81		826	940	
6360	400 watt		2.10	3.810		816	92		908	1,025	
6370	Wall, surface mounted, 175 watt		2.90	2.760		698	67		765	865	
6380	250 watt		2.70	2.960		805	72		877	990	
6390	400 watt		2.40	3.330		856	81		937	1,050	
6400	High pressure sodium, ceiling surface mounted, 70 watt		3	2.670		724	65		789	890	
6410	100 watt		3	2.670		738	65		803	905	
6420	150 watt		2.70	2.960		765	72		837	945	
6430	Pendent mounted, 70 watt		2.70	2.960		678	72		750	850	
6440	100 watt		2.70	2.960		698	72		770	875	
6450	150 watt		2.40	3.330		724	81		805	915	
6460	Wall mounted, 70 watt		3	2.670		750	65		815	920	
6470	100 watt		3	2.670		775	65		840	945	
6480	150 watt		2.70	2.960		780	72		852	965	
6510	Incandescent, ceiling mounted, 200 watt		4	2		250	49		299	345	
6520	Pendent mounted, 200 watt		3.50	2.290		219	55		274	320	
6530	Wall mounted, 200 watt		4	2		270	49		319	370	
6600	Fluorescent, RS, 4' long, ceiling mounted, two 40 watt		2.70	2.960		1,310	72		1,382	1,550	
6610	Three 40 watt 		2.20	3.640		1,915	88		2,003	2,225	
6620	Four 40 watt		1.90	4.210		2,490	100		2,590	2,900	
6630	Pendent mounted, two 40 watt		2.30	3.480		1,390	84		1,474	1,650	
6640	Three 40 watt		1.90	4.210		2,020	100		2,120	2,375	
6650	Four 40 watt		1.70	4.710		2,570	115		2,685	3,000	
6700	Mercury vapor with ballast, surface mounted, 175 watt		2.70	2.960		545	72		617	705	
6710	250 watt		2.70	2.960		586	72		658	750	
6740	400 watt		2.40	3.330		714	81		795	905	
6750	Pendent mounted, 175 watt		2.40	3.330		550	81		631	725	
6760	250 watt		2.40	3.330		561	81		642	735	
6770	400 watt		2.10	3.810		683	92		775	885	
6780	Wall mounted, 175 watt		2.70	2.960		576	72		648	740	
6790	250 watt		2.70	2.960		632	72		704	800	
6820	400 watt		2.40	3.330		750	81		831	945	
6850	Vandalproof, surface mounted, fluorescent, two 40 watt		3.20	2.500		105	61		166	205	
6860	Incandescent, one 150 watt		8	1		45	24		69	85	
6900	Mirror light, fluorescent, RS, acrylic enclosure, two 40 watt		8	1		61	24		85	105	
6910	One 40 watt		8	1		56	24		80	97	
6920	One 20 watt		12	.667		49	16.15		65.15	78	
7000	Low bay, aluminum reflector, 70 watt, high pressure sodium		4	2		298	49		347	400	
7010	250 watt, high pressure sodium		3.20	2.500		535	61		596	680	
7020	400 watt, high pressure sodium		2.50	3.200		561	78		639	730	
7500	Ballast replacement, by weight of ballast, to 15' high										
7520	Indoor fluorescent, less than 2 lbs.	1 Elec	10	.800	Ea.		19.40		19.40	29	
7540	2 40W, watt reducer, 2 to 5 lbs.	"	9.40	.851	"	17	21		38	49	

GP-N-6 Replace explosion proof 150W incandescents with 50 W HPS fixtures

Note: 50 W HPS has been color corrected. 35 W HPS would provide equivalent lumens but yellowish light.

$$\text{Energy savings} = (150\text{ W} - 70\text{ W}) \times 24 \frac{\text{hr}}{\text{day}} \times \frac{365\text{ days}}{\text{yr}} = 701 \frac{\text{kwh}}{\text{yr}}$$

$$\text{Energy Cost savings} = 701 \frac{\text{kwh}}{\text{yr}} \times \frac{\$0.03026}{\text{kwh}} = \frac{\$21.21}{\text{yr}}$$

$$\text{Mat'l \& Labor cost savings} = \left(\frac{\text{Incand. cost}}{750\text{ hr}} - \frac{\text{HPS cost}}{24{,}000\text{ hr}}\right) \times 8760 \frac{\text{hr}}{\text{yr}}$$

$$= \left[\frac{(\$2.11\text{ mat'l} + \$1.20\text{ labor} \times 0.683 \times 1.2\text{ exp-pf})}{750\text{ hr}} - \frac{(\$30\text{ mat'l} + \$6.45\text{ labor} \times 0.683 \times 1.2)}{24{,}000\text{ hr}}\right]$$

$$\times \frac{8760\text{ hr}}{\text{yr}} = \frac{\$23.25}{\text{yr}}$$

$$\text{Total cost savings} = \frac{\$21.21}{\text{yr}} + \frac{\$23.25}{\text{yr}} = \frac{\$44.46}{\text{yr}}$$

Mat'l cost = \$220 for fixture w/lamp × 1.15 inflation (1985 vendor quote)

Labor cost = \$72 × 1.2 exp proof × 0.683 = \$59.01

Construction cost = [(\$253 × 1.045) + (\$59.01 × 1.2)] × 1.507 = \$505

$$\text{Simple payback} = \frac{\$505}{\$44.46/\text{yr}} = 11.4\text{ yr}$$ > 10 yrs ⇒ not recommended

GP-N-6 p. 2 of 10

ECP ENERGY CONSERVATION PRODUCTS, 511 CANAL STREET, NYC, NY, 10013—TEL (212)-925-5991

POWER CONSUMPTION AND LUMEN OUTPUT DATA

	WATTS	LINE WATTS	TOTAL LUMEN OUTPUT	LUMENS PER WATT	HOURS OF RATED LIFE
********* MERCURY VAPOR (DELUXE WHITE)					
*	1000	1075	63000	59	24000
*	400	450	23000	56	24000
*	250	290	13000	42	24000
*	175	205	8500	49	24000
*	100	120	4500	42	24000
*	75	93	3150	37	16000
*	50	61	1680	31	16000
********* METAL HALIDE					
*	1500	1600	155000	103	3000
*	1000	1100	110000	100	12000
*	400	460	34000	85	15000
*	175	210	14000	85	7500
********* HIGH PRESSURE SODIUM					
*	1000	1080	140000	130	24000
*	400	480	50000	104	24000
*	250	310	27500	89	24000
*	150	200	16000	80	24000
*	100	135	9500	70	24000
*	70	85	5800	68	24000
*	50	70	4000	57	24000
*	35	42	2850	67	18000
*********FLUORESCENT					
STRAIGHT	40	48	3150	66	20000+
CIRCLINE	32	37	1830	50	12000+
CIRCLINE	22	25	1050	42	12000+
CIRCLINE	20	23	850	37	12000+
TWIN TUBE	13	16	900	56	10000+
TWIN TUBE	9	12	600	50	10000+
STRAIGHT	8	11	400	36	7500+
TWIN TUBE	7	10	400	40	10000+
STRAIGHT	6	9	300	33	7500+
TWIN TUBE	5	8	250	31	10000+
********* INCANDESCENT					
*	1000	1000	23740	24	1000
*	750	750	17040	23	1000
*	500	500	10850	22	1000
*	200	200	3710	19	750
*	150	150	2880	19	750
*	100	100	1750	18	750
*	75	75	1190	16	750
********* QUARTS—IODINE					
*	1500	1500	35800	24	3000
*	1000	1000	23400	23	2000
*	500	500	10950	22	2600
*	250	250	4850	19	2000

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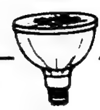
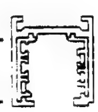
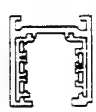
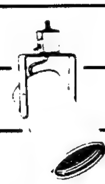
	Line	Description	Crew	Daily Output	Man-Hours	Unit	Bare Costs Mat.	Bare Costs Labor	Bare Costs Equip.	Bare Costs Total	Total Incl O&P	
140	1600	90 watt	1 Elec	.30	26.670	C	5,140	645		5,785	6,600	140
	1650	135 watt		.20	40		6,905	970		7,875	9,025	
	1700	180 watt		.20	40		7,308	970		8,278	9,475	
	1750	Quartz line, clear, 500 watt		1.10	7.270		1,872	175		2,047	2,325	
	1760	1500 watt		.20	40		3,427	970		4,397	5,200	
	1800	Incandescent, interior, A21, 100 watt		1.60	5		173	120		293	370	
	1900	A21, 150 watt		1.60	5		211	120		331	410	
	2000	A23, 200 watt		1.60	5		227	120		347	430	
	2200	PS 30, 300 watt 		1.60	5		330	120		450	540	
	2210	PS 35, 500 watt		1.60	5		576	120		696	810	
	2230	PS 52, 1000 watt		1.30	6.150		1,525	150		1,675	1,900	
	2240	PS 52, 1500 watt		1.30	6.150		2,382	150		2,532	2,850	
	2300	R30, 75 watt		1.30	6.150		375	150		525	630	
	2400	R40, 150 watt		1.30	6.150		408	150		558	670	
	2500	Exterior, PAR 38, 75 watt 		1.30	6.150		566	150		716	840	
	2600	PAR 38, 150 watt		1.30	6.150		525	150		675	795	
	2700	PAR 46, 200 watt		1.10	7.270		1,928	175		2,103	2,375	
	2800	PAR 56, 300 watt		1.10	7.270		2,193	175		2,368	2,675	
	3000	Guards, fluorescent lamp, 4' long		1	8		375	195		570	695	
	3200	8' long		.90	8.890		535	215		750	905	
145	0010	**RESIDENTIAL FIXTURES**										145
	0400	Fluorescent, interior, surface, circline, 32 watt & 40 watt	1 Elec	20	.400	Ea.	48	9.70		57.70	67	
	0500	2' x 2', two U 40 watt		8	1		66	24		90	110	
	0700	Shallow under cabinet, two 20 watt		16	.500		45	12.15		57.15	67	
	0900	Wall mounted, 4'L, one 40 watt, with baffle		10	.800		41	19.40		60.40	74	
	2000	Incandescent, exterior lantern, wall mounted, 60 watt		16	.500		36	12.15		48.15	57	
	2100	Post light, 150W, with 7' post		4	2		104	49		153	185	
	2500	Lamp holder, weatherproof with 150W PAR		16	.500		16	12.15		28.15	35	
	2550	With reflector and guard		12	.667		31	16.15		47.15	58	
	2600	Interior pendent, globe with shade, 150 watt		20	.400		78	9.70		87.70	100	
150	0010	**TRACK LIGHTING**										150
	0080	Track, 1 circuit, 4' section 	1 Elec	6.70	1.190	Ea.	33	29		62	79	
	0100	8' section		5.30	1.510		48	37		85	105	
	0200	12' section		4.40	1.820		81	44		125	155	
	0300	3 circuits, 4' section 		6.70	1.190		36	29		65	82	
	0400	8' section		5.30	1.510		48	37		85	105	
	0500	12' section		4.40	1.820		88	44		132	160	
	1000	Feed kit, surface mounting		16	.500		12	12.15		24.15	31	
	1100	End cover		24	.333		1.98	8.10		10.08	14.05	
	1200	Feed kit, stem mounting, 1 circuit		16	.500		16	12.15		28.15	35	
	1300	3 circuit		16	.500		16	12.15		28.15	35	
	2000	Electrical joiner for continuous runs, 1 circuit		32	.250		6.55	6.05		12.60	16.10	
	2100	3 circuit		32	.250		12.10	6.05		18.15	22	
	2200	Fixtures, spotlight, 150 PAR 		16	.500		47	12.15		59.15	70	
	3000	Wall washer, 250 watt tungsten halogen		16	.500		101	12.15		113.15	130	
	3100	Low voltage, 25/50 watt, 1 circuit		16	.500		102	12.15		114.15	130	
	3120	3 circuit		16	.500		109	12.15		121.15	140	

HUNTER **Telephone Call Confirmation**

Project No. 290 0379000

Local ______ L.D. (718) 851-4577 Placed ✓ Rec'd. ✓ Date 6-7-90

T. Todd Conversed With Mr. Singer

Of American Scientific Lighting Co. Regarding HPS retrofits

For retrofits of incandescent fixtures, the "Bulb Lumenight" and "Colorlight" products are recommended. The lamps are replaceable in both, and the "colorlight" is more whitish. Contractors costs (including lamp) for quantities of 100+ are as follows:

Bulb Lumenight	35 W	$45	(lamps only
	50 W	$45	$16 - $20)

(also come in 70 W, 100 W, 150 W)

Colorlight	50 W	$67	(lamps only
			$30)

They will send a copy of their catalog for dimensions.

Distribution:

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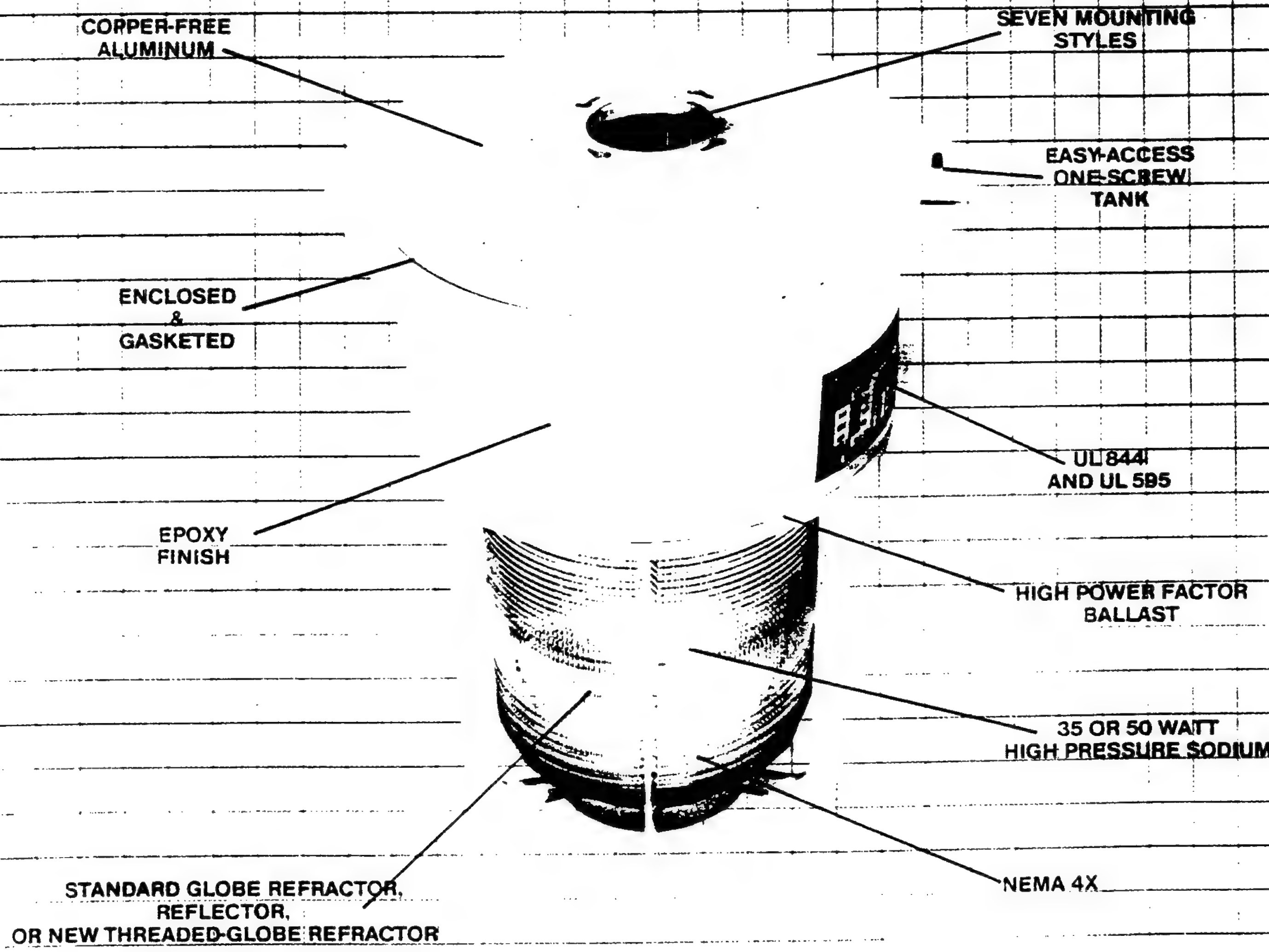
			CREW	DAILY OUTPUT	MAN-HOURS	UNIT	BARE COSTS MAT.	BARE COSTS LABOR	BARE COSTS EQUIP.	BARE COSTS TOTAL	TOTAL INCL O&P	
135	5100	175 watt metal halide	1 Elec	8	1	Ea.	479	24		503	565	135
	5110	250 watt metal halide		8	1		500	24		524	585	
	5120	150 watt high pressure sodium		8	1		535	24		559	625	
	5130	250 watt high pressure sodium		8	1		556	24		580	645	
	5140	72"H 18" sq., 400 watt metal halide		8	1		525	24		549	615	
	5150	250 watt high pressure sodium		8	1		556	24		580	645	
	5160	400 watt high pressure sodium		8	1		581	24		605	675	
	5190	Portable rectangle, 6" high 13.5" x 20"										
	5200	175 watt metal halide	1 Elec	12	.667	Ea.	293	16.15		309.15	345	
	5210	250 watt metal halide		12	.667		314	16.15		330.15	370	
	5220	150 watt high pressure sodium		12	.667		335	16.15		351.15	390	
	5230	250 watt high pressure sodium		12	.667		360	16.15		376.15	420	
	5240	8" high 18" x 24", 400 watt metal halide		12	.667		365	16.15		381.15	425	
	5250	250 watt high pressure sodium		12	.667		376	16.15		392.15	435	
	5260	400 watt high pressure sodium		12	.667		398	16.15		414.15	460	
	5270	Portable square, 15" high 13.5" sq., 175 watt metal halide		12	.667		324	16.15		340.15	380	
	5280	250 watt metal halide		12	.667		376	16.15		392.15	435	
	5290	150 watt high pressure sodium		12	.667		360	16.15		376.15	420	
	5300	250 watt high pressure sodium		12	.667		386	16.15		402.15	450	
	5400	Pendent 16" round/square, 175 watt metal halide		3.20	2.500		355	61		416	480	
	5410	250 watt metal halide		2.70	2.960		370	72		442	515	
	5420	400 watt metal halide		2.40	3.330		398	81		479	555	
	5430	150 watt high pressure sodium		3.20	2.500		398	61		459	525	
	5440	250 watt high pressure sodium		2.70	2.960		428	72		500	575	
	5450	400 watt high pressure sodium		2.40	3.330		454	81		535	620	
140	0010	LAMPS										140
	0080	Fluorescent, rapid start, cool white, 2' long, 20 watt	1 Elec	1	8	C	348	195		543	670	
	0100	4' long, 40 watt		.90	8.890		198	215		413	535	
	0120	3' long, 30 watt		.90	8.890		442	215		657	805	
	0150	U-40 watt		.80	10		874	245		1,119	1,325	
	0170	4' long, 35 watt energy saver		.90	8.890		270	215		485	615	
	0200	Slimline, 4' long, 40 watt		.90	8.890		618	215		833	995	
	0300	8' long, 75 watt		.80	10		577	245		822	990	
	0350	8' long, 60 watt energy saver		.80	10		603	245		848	1,025	
	0400	High output, 4' long, 60 watt		.90	8.890		750	215		965	1,150	
	0500	8' long, 110 watt		.80	10		775	245		1,020	1,200	
	0520	Very high output, 4' long, 110 watt		.90	8.890		1,285	215		1,500	1,725	
	0550	8' long, 215 watt		.70	11.430		1,285	275		1,560	1,825	
	0600	Mercury vapor, mogul base, deluxe white, 100 watt		.30	26.670		2,142	645		2,787	3,300	
	0650	175 watt		.30	26.670		1,663	645		2,308	2,775	
	0700	250 watt		.30	26.670		2,968	645		3,613	4,225	
	0800	400 watt		.30	26.670		2,340	645		2,985	3,525	
	0900	1000 watt		.20	40		5,100	970		6,070	7,025	
	1000	Metal halide, mogul base, 175 watt		.30	26.670		3,749	645		4,394	5,075	
	1100	250 watt		.30	26.670		4,712	645		5,357	6,125	
	1200	400 watt		.30	26.670		4,386	645		5,031	5,775	
	1300	1000 watt		.20	40		9,894	970		10,864	12,300	
	1320	1000 watt, 125,000 initial lumens		.20	40		9,960	970		10,930	12,400	
	1330	1500 watt		.20	40		9,268	970		10,238	11,600	
	1350	Sodium high pressure, 70 watt		.30	26.670		4,712	645		5,357	6,125	
	1360	100 watt		.30	26.670		4,871	645		5,516	6,300	
	1370	150 watt		.30	26.670		5,059	645		5,704	6,525	
	1380	250 watt		.30	26.670		5,380	645		6,025	6,875	
	1400	400 watt		.30	26.670		5,727	645		6,372	7,250	
	1450	1000 watt		.20	40		13,352	970		14,322	16,100	
	1500	Low pressure, 35 watt		.30	26.670		3,963	645		4,608	5,300	
	1550	55 watt		.30	26.670		4,386	645		5,031	5,775	

HAZLUX®

35/50

LOW WATTAGE HIGH PRESSURE SODIUM FIXTURES



- **EASILY REPLACES OR RETROFITS INCANDESCENT FIXTURES**
- **1 TO 3 YEAR PAYBACK**
- **35 WATT H.P.S. REPLACES 100/150 INCANDESCENTS**
- **50 WATT H.P.S. REPLACES 150/200 INCANDESCENTS**

HAZLUX® 35/50

ENCLOSED & GASKETED

CLASS I, DIVISION 2
CLASS II, DIVISIONS 1 and 2
CLASS III

UL 844/UL 595 LISTED

NOW, 35 WATT HIGH PRESSURE SODIUM FOR HAZARDOUS LOCATION APPLICATIONS

SUITABLE FOR MOST INDUSTRIAL APPLICATIONS...

The HAZLUX 35/50 is the first low wattage High Pressure Sodium fixture designed for hazardous location operations. It is UL 844 listed and is ideal for eye-level operations where fixtures are lower and closer to production such as corridors, production sites, and low overhead facilities like stairwells, catwalks, and tunnels.

RETURN ON INVESTMENT IN ONE TO THREE YEARS...

Depending on your application, the HAZLUX 35/50 fixture can pay for itself in one to three years. It uses less energy, provides more light, and dramatically reduces relamping maintenance in comparison to incandescent fixtures.

MORE LIGHT USING LESS ENERGY...

The HAZLUX 35/50 uses efficient High Pressure Sodium lamps which use less power to produce more light. A 35 Watt H.P.S. lamp provides 25% more lumens using less than half the power of a 100 Watt incandescent.

LESS RELAMPING SAVES LAMP COSTS & LABOR...

High Pressure Sodium lamps operate up to 24,000 hours; typical incandescent lamps last only 750 hours. Compare the HAZLUX 35/50 which requires relamping once or twice in five years to an incandescent fixture demanding more than 30 relampings in the same period.

THE IDEAL RETROFIT FOR EXISTING INCANDESCENT FIXTURES...

The HAZLUX 35/50 easily fits on existing incandescent fittings through the use of HAZLUX Outlet box "V010" which fits standard "ordinary location" four inch outlet boxes. Retrofitting to more economical and more efficient High Pressure Sodium 35 or 50 Watt lamps could not be easier.

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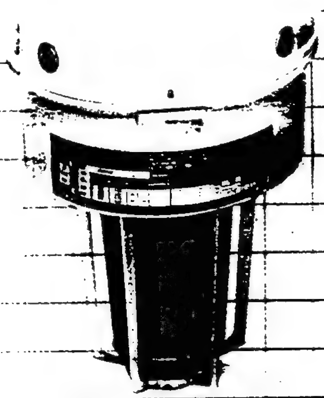
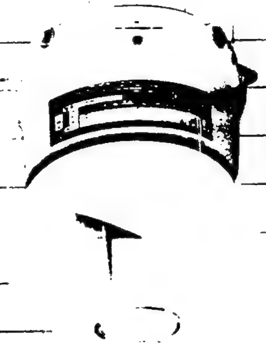
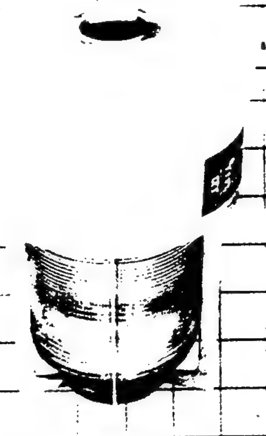


GLOBE/GUARD TYPE



STANDARD OR ANGLE REFLECTORS



THREADED-GLOBE "TR" REFRACTOR

THE TYPICAL COST TO OPERATE ONE HAZLUX 35/50 IS $20.05 ANNUALLY...COMPARED TO $101.88 TO OPERATE AN INCANDESCENT FIXTURE FOR ONE YEAR.

COMPARE THE FACTS

1. H.P.S. lamps consume less energy but produce more lumens than incandescents.
2. H.P.S. lamps last more than 30 times longer than incandescents.

COST COMPARISON CHART

	HAZLUX 35W H.P.S.	HAZLUX 50W H.P.S.	INCANDESCENT FIXTURES 100W		INCANDESCENT FIXTURES 150W		INCANDESCENT FIXTURES 200W	
LUMENS	2200	4000	1750	1490	2880	2310	4010	3410
ENERGY CONSUMED	43 W	60 W	100 W	100 W	150 W	150 W	200 W	200 W
ENERGY COST PER YEAR (1)	$9.42	$13.14	$21.90	$21.90	$32.85	$32.85	$43.80	$43.80
LAMP LIFE IN HOURS	16,000 (A)	24,000	750	2,500	750	2,500	750	2,500
LAMPS BOUGHT PER YEAR	.27	.18	5.8	1.75	5.8	1.75	5.8	1.75
COST OF LAMPS BOUGHT PER YEAR	$8.21	$5.47	$2.92	$1.75	$5.84	$3.50	$11.68	$7.00
LAMPING LABOR PER YEAR (2)	$2.16	$1.44	$46.40	$14.00	$46.40	$14.00	$46[illegible]	$14.00
ANNUAL COST	$19.79	$20.05	$71.22	$37.65	$85.09	$50.35	$101.88	$64.80

1. Determined at .05 KWH.
2. Determined at $8.00 per relamping

A) This lamp may soon be upgraded to 24,000 hours

Chart based on 4,380 hours burning time per year (12 hours per day x 365 days).
Lamp costs: 35W = $30; 50W = $30; 100W = $.50/1.00; 150W = $1.00/2.00; 200W = $2.00/4.00
Comparisons should not be made solely on the above figures. Wire size, feeders, buss, circuit breakers, etc., must be considered – along with safety, reliability and fewer fixtures required.

CATALOG NUMBERS & PRICING *

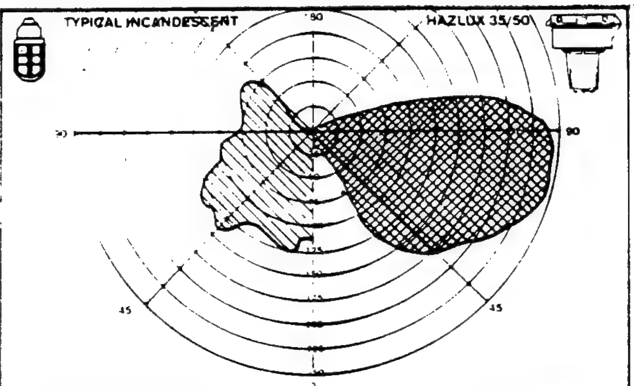
(120 V.A.C. STANDARD)

	 PENDANT	 CONE PENDANT	 WALL	 STANCHION	CEILING	 OUTLET BOX
STANDARD GLOBE	35 WATT DS03P12-GG-P2 $207.00	DS03P12-GG-A2 $238.00	DS03P12-GG-B2 $226.00	DS03P12-GG-S4 $226.00	DS03P12-GG-C2 $210.00	DS03P12-GG-010 $210.00
	50 WATT DS05P12-GG-P2 $220.00	DS05P12-GG-A2 $25[illegible]	DS05P12-GG-B2 $239.00	DS05P12-GG-S4 $239.00	DS05P12-GG-C2 $222.00	[illegible]
THREADED "TR" REFRACTOR GLOBE	35 WATT DS03P12R-R5G-P2 $236.00	DS03P12R-R5G-A2 $267.00	DS03P12R-R5G-B2 $255.00	DS03P12R-R5G-S4 $255.00	DS03P12R-R5G-C2 $239.00	DS03P12R-R5G-010 $239.00
	50 WATT DS05P12R-R5G-P2 $249.00	[illegible] $280.00	DS05P12R-R5G-B2 $268.00	[illegible] $268.00	[illegible] $252.00	[illegible] $2[illegible]

*Catalog Numbers listed include Globe & Guard, 3/4" Conduit Opening; (1 1/4" Stanchion). "TR" Type V Refractor & Guard. 1" Conduit Openings and 1 1/2" Stancion Conduit Openings Available. Angle, Standard Dome Reflectors, and Types I and III Refractors Available; consult Factory.

For Flexible Pendant Substitute "F2" for "P2" in Pendant Mount Catalog Number.

PHOTOMETRICS

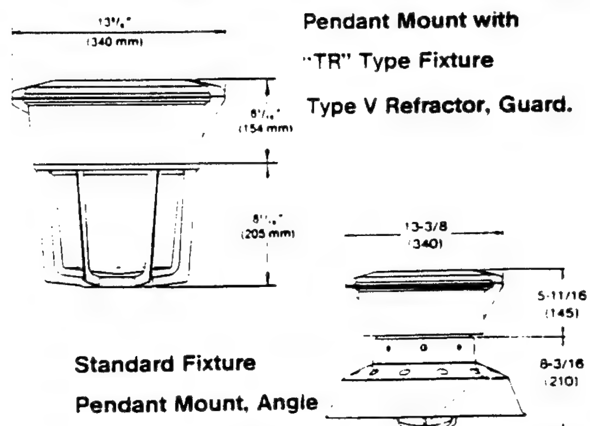


TYPICAL INCANDESCENT
- 100 WATT
- 1750 LUMENS
- 69% TO 75% EFFICIENCY

HAZLUX 35/50
- 35 WATT H.P.S.
- 2200 LUMENS
- 82% EFFICIENCY

THIS CHART COMPARES THE LUMEN OUTPUT OF A HAZLUX 35 WATT HIGH PRESSURE SODIUM FIXTURE TO A TYPICAL 100 WATT INCANDESCENT FIXTURE.

DIMENSIONS



Pendant Mount with "TR" Type Fixture Type V Refractor, Guard.

Standard Fixture Pendant Mount, Angle or Standard Reflector. Globe. Guard.

The HAZLUX 3
enclosed & gasketed
35 to 1000 watts

The HAZLUX 5
explosion-proof
50-250 watts

ITT WEAVER
8676 Pennell Drive
St. Louis, MO 63114

GP-N-6 P.10 of 10

166 100 | Lighting		CREW	DAILY OUTPUT	MAN-HOURS	UNIT	BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P
60[illegible]	Recessed, 200 watt	1 Elec	6.70	1.190	Ea.	51	29		80	99
6030	Pendent, 200 watt		6.70	1.190		43	29		72	90
6040	Wall, 200 watt		8	1		44	24		68	84
6100	Fluorescent, surface mounted, 2 lamps, 4'L, RS, 40 watt		3.20	2.500		70	61		131	165
6110	Industrial, 2 lamps 4' long in tandem, 430 MA		2.20	3.640		139	88		227	280
6130	2 lamps 4' long, 800 MA		1.90	4.210		100	100		200	260
6160	Pendent, indust, 2 lamps 4'L in tandem, 430 MA		1.90	4.210		149	100		249	315
6170	2 lamps 4' long, 430 MA		2.30	3.480		80	84		164	210
6180	2 lamps 4' long, 800 MA		1.70	4.710		109	115		224	290
6200	Mercury vapor with ballast, 175 watt		3.20	2.500		226	61		287	340
6300	Explosionproof									
6310	Metal halide, ballast, ceiling, surface mounted, 175 watt	1 Elec	2.90	2.760	Ea.	668	67		735	835
6320	250 watt		2.70	2.960		775	72		847	960
6330	400 watt		2.40	3.330		836	81		917	1,050
6340	Ceiling, pendent mounted, 175 watt		2.60	3.080		640	75		715	815
6350	250 watt		2.40	3.330		745	81		826	940
6360	400 watt		2.10	3.810		816	92		908	1,025
6370	Wall, surface mounted, 175 watt		2.90	2.760		698	67		765	865
6380	250 watt		2.70	2.960		805	72		877	990
6390	400 watt		2.40	3.330		856	81		937	1,050
6400	High pressure sodium, ceiling surface mounted, 70 watt		3	2.670		724	65		789	890
6410	100 watt		3	2.670		738	65		803	905
6420	150 watt		2.70	2.960		765	72		837	945
6430	Pendent mounted, 70 watt		2.70	2.960		678	72		750	850
6440	100 watt		2.70	2.960		698	72		770	875
6450	150 watt		2.40	3.330		724	81		805	915
[illegible]	Wall mounted, 70 watt		3	2.670		750	65		815	920
6470	100 watt		3	2.670		775	65		840	945
6480	150 watt		2.70	2.960		780	72		852	965
6510	Incandescent, ceiling mounted, 200 watt		4	2		250	49		299	345
6520	Pendent mounted, 200 watt		3.50	2.290		219	55		274	320
6530	Wall mounted, 200 watt		4	2		270	49		319	370
6600	Fluorescent, RS, 4' long, ceiling mounted, two 40 watt		2.70	2.960		1,310	72		1,382	1,550
6610	Three 40 watt		2.20	3.640		1,915	88		2,003	2,225
6620	Four 40 watt		1.90	4.210		2,490	100		2,590	2,900
6630	Pendent mounted, two 40 watt		2.30	3.480		1,390	84		1,474	1,650
6640	Three 40 watt		1.90	4.210		2,020	100		2,120	2,375
6650	Four 40 watt		1.70	4.710		2,570	115		2,685	3,000
6700	Mercury vapor with ballast, surface mounted, 175 watt		2.70	2.960		545	72		617	705
6710	250 watt		2.70	2.960		586	72		658	750
6740	400 watt		2.40	3.330		714	81		795	905
6750	Pendent mounted, 175 watt		2.40	3.330		550	81		631	725
6760	250 watt		2.40	3.330		561	81		642	735
6770	400 watt		2.10	3.810		683	92		775	885
6780	Wall mounted, 175 watt		2.70	2.960		576	72		648	740
6790	250 watt		2.70	2.960		632	72		704	800
6820	400 watt		2.40	3.330		750	81		831	945
6850	Vandalproof, surface mounted, fluorescent, two 40 watt		3.20	2.500		105	61		166	205
6860	Incandescent, one 150 watt		8	1		45	24		69	85
6900	Mirror light, fluorescent, RS, acrylic enclosure, two 40 watt		8	1		61	24		85	105
6910	One 40 watt		8	1		56	24		80	97
6920	One 20 watt		12	.667		49	16.15		65.15	78
7[illegible]	Low bay, aluminum reflector, 70 watt, high pressure sodium		4	2		298	49		347	400
7010	250 watt, high pressure sodium		3.20	2.500		535	61		596	680
7020	400 watt, high pressure sodium		2.50	3.200		561	78		639	730
7500	Ballast replacement, by weight of ballast, to 15' high									
7520	Indoor fluorescent, less than 2 lbs.	1 Elec	10	.800	Ea.		19.40		19.40	29
7540	2 40W, watt reducer, 2 to 5 lbs.	•	9.40	.851	•	17	21		38	49

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT RAAP Ballast Project
Screening Calc.
DESIGNER T. Todd
CHECKER

AEP NO 290 0379 000
SHEET 1 OF 4
DATE
DATE

GP-N-7
Replace existing ballasts with energy efficient ballasts in fluorescent 4' fixtures

- Assume lamps will be retrofitted with ballasts for compatibility & acceptable light output.
- Calculations show energy savings and costs for ballasts only.
- Assume standard 2-lamp industrial ballast is replaced with watt-miser 2-lamp ballast.

Energy savings = $[96 - 2(40)] - [71 - 2(34)]$ W = 13 W/fixture

$= \frac{13\ W}{fixture} \times \frac{24\ hr}{day} \times \frac{365\ days}{yr} = 114\ \frac{kwh}{yr}$ max.

Cost savings $= \frac{114\ kwh}{yr} \times \frac{\$0.03026}{kwh} = \frac{\$3.45}{yr}$

Cost for mat'l only = \$21.94 (1987 vendor quote)

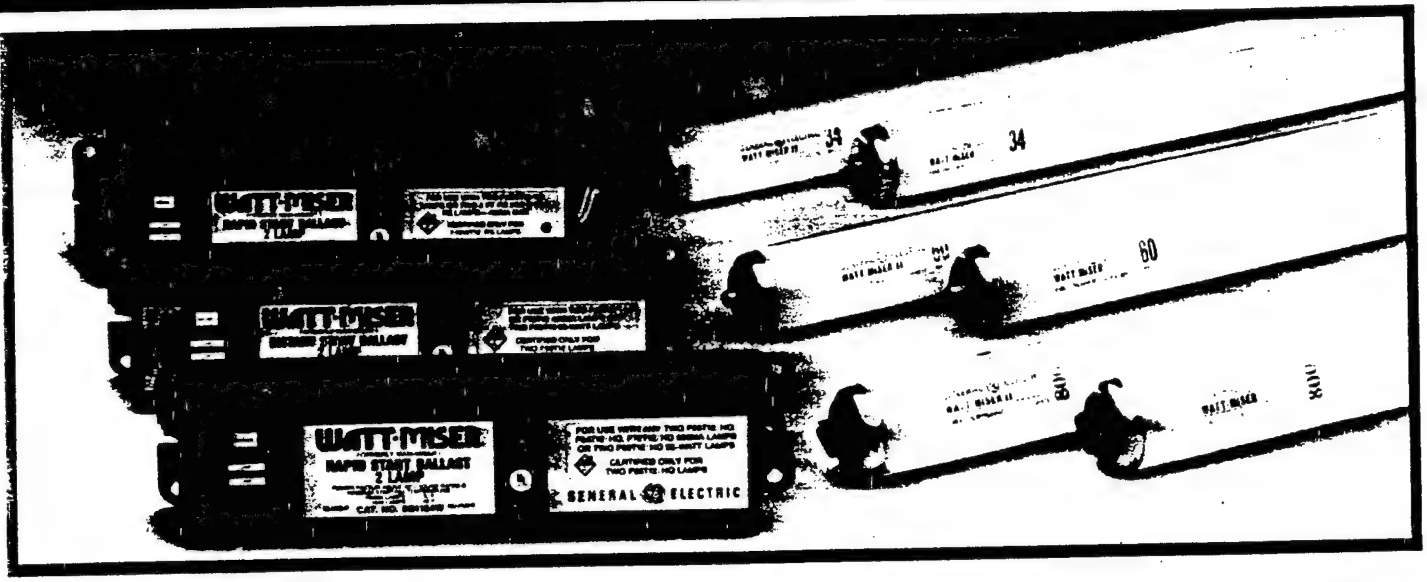
assuming 5% inflation to 1990\$, material cost = \$23.04
Cost for labor = \$21 (1989 Means Electrical)
Construction cost = [\$23.04 + (\$21 × 0.683)] × 1.507 = \$56.34

Simple payback $= \frac{\$56.34}{\$3.45/yr} = 16.3\ yr > 10\ yr$

this project is not recommended due to high payback even when continuous operation is assumed.

(see combination ballast / relamping project)

GE WATT-MISER™ BALLASTS USE LESS WATTS PER FIXTURE TO DELIVER HIGH ENERGY SAVINGS



Watt-Miser Ballasts

- Compatible with standard or energy-saving lamps (3-lamp WM ballast compatible only with ES lamps)
- Cooler operation extends ballast life
- Dimensionally interchangeable with standard ballasts.
- CBM-certified by ETL with standard lamps. (3-lamp WM ballast not CBM certified)
- UL-listed, Class P.

The GE Watt-Miser ballast is inherently more energy-efficient than a standard ballast. Even greater savings come from pairing Watt-Miser ballasts with today's popular reduced-wattage lamps. Watt-Miser ballasts are offered for 4′ Rapid Start; 8′ Instant Start; and 8′ High Output applications. A 3-lamp Watt-Miser ballast in a standard rapid start case is available for use with four-foot energy-saving lamps. The chart shows fixture watts and energy $ that can be saved by replacing standard lamps and ballasts with Watt-Miser ballasts and energy-saving lamps.

Lamp/Ballast System Replacement Chart

Fluorescent Fixture Type	Standard System(1)		Watt-Miser System			
	Lamp Type	Watts Per Fixture	Lamp Type(2)	Watt-Miser Ballast(4)	Watts Saved Per Fixture	Energy(3) $ Saved Per Fixture
4-LAMP TROFFER	F40 F40 (34W)	181 159	F40LW/RS/WMII F40LW/RS/WMII	(2)8G1024W (2)8G1024W	41 19	$ 9.84 $ 4.56
3-LAMP TROFFER	F40	149	F40LW/RS/WMII	(1)8G1024W and (1)8G1074W (1)8G1324W	40 43	$ 9.60 $10.32
2-LAMP INDUSTRIAL	F40 F96T12 F96T12/HO	96 172 255	F40LW/RS/WMII F96T12/LW/WMII F96T12/LW/HO/WMII	8G1024W 8G1004W 8G1154W	25 46 56	$ 6.00 $16.56 $20.16
2-LAMP, SURFACE-MOUNT, WRAP AROUND	F40	82	F40LW/RS/WMII	8G1024W	16	$ 3.36
4-LAMP, SURFACE-MOUNT, WRAP AROUND	F40	165	F40LW/RS/WMII	(2)8G1024W	32	$ 6.72

(1) Fixture equipped with standard ballast and lamp shown.
(2) Other energy-saving lamps may be used to obtain similar savings.
(3) Annual energy savings at 8¢ KWH; 3000 Hrs.—F40; 4500 Hrs.—F96.
(4) Ballast codes shown are 120-volt. For complete application information, see product tables.

GR-N-F [illegible]

Project No. 87-210-00

PTAC No. 865911

Telephone Call Confirmation

reynolds, smith and hills

Local 396-7446 L.D. (813) Tampa 988-7351 Placed ✓ Rec'd ______ Date 5-27-87

T. Masters Conversed with Stan Jefson / Joe Howley

Of G.E. Lamp Marketing / Engineering Regarding ballasts

Stan Jefson provided costs, Joe Howley provided wattages, light output, lifetimes

4 ft			Cost	Life (function of heat)
Standard	8G1022WF	(S)	$15.86	10-12 yr
Wattmiser	8G1024 WF	(W)	$21.94	24 yr
Maximiser II	8G1028WF	(M)	$22.89	24 yr
Optimiser	M28-120F	(O)	$34.10	30 yr

energy-efficient

- Maximiser II - patented, full light output using energy saving lamps, may be able to delamp with this one
- Optimiser - patented, newest, lowest wattage input

8 ft				
Standard	8G1011WF	(S)	$25.90	12 yr
Wattmiser	8G1004WF	(W)	$36.86	24 yr
Maximiser II	8G1008WF	(M)	$39.17	24 yr

Distribution:

166 | Lighting

166 100 | Lighting

	166 100 Lighting	CREW	DAILY OUTPUT	MAN-HOURS	UNIT	BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
130 6020	Recessed, 200 watt	1 Elec	6.70	1.190	Ea.	51	29		80	99	130
6030	Pendent, 200 watt		6.70	1.190		43	29		72	90	
6040	Wall, 200 watt		8	1		44	24		68	84	
6100	Fluorescent, surface mounted, 2 lamps, 4'L, RS, 40 watt		3.20	2.500		70	61		131	165	
6110	Industrial, 2 lamps 4' long in tandem, 430 MA		2.20	3.640		139	88		227	280	
6130	2 lamps 4' long, 800 MA		1.90	4.210		100	100		200	260	
6160	Pendent, indust, 2 lamps 4'L in tandem, 430 MA		1.90	4.210		149	100		249	315	
6170	2 lamps 4' long, 430 MA		2.30	3.480		80	84		164	210	
6180	2 lamps 4' long, 800 MA		1.70	4.710		109	115		224	290	
6200	Mercury vapor with ballast, 175 watt		3.20	2.500		226	61		287	340	
6300	Explosionproof										
6310	Metal halide, ballast, ceiling, surface mounted, 175 watt	1 Elec	2.90	2.760	Ea.	668	67		735	835	
6320	250 watt		2.70	2.960		775	72		847	960	
6330	400 watt		2.40	3.330		836	81		917	1,050	
6340	Ceiling, pendent mounted, 175 watt		2.60	3.080		640	75		715	815	
6350	250 watt		2.40	3.330		745	81		826	940	
6360	400 watt		2.10	3.810		816	92		908	1,025	
6370	Wall, surface mounted, 175 watt		2.90	2.760		698	67		765	865	
6380	250 watt		2.70	2.960		805	72		877	990	
6390	400 watt		2.40	3.330		856	81		937	1,050	
6400	High pressure sodium, ceiling surface mounted, 70 watt		3	2.670		724	65		789	890	
6410	100 watt		3	2.670		738	65		803	905	
6420	150 watt		2.70	2.960		765	72		837	945	
6430	Pendent mounted, 70 watt		2.70	2.960		678	72		750	850	
6440	100 watt		2.70	2.960		698	72		770	875	
6450	150 watt		2.40	3.330		724	81		805	915	
6460	Wall mounted, 70 watt		3	2.670		750	65		815	920	
6470	100 watt		3	2.670		775	65		840	945	
6480	150 watt		2.70	2.960		780	72		852	965	
6510	Incandescent, ceiling mounted, 200 watt		4	2		250	49		299	345	
6520	Pendent mounted, 200 watt		3.50	2.290		219	55		274	320	
6530	Wall mounted, 200 watt		4	2		270	49		319	370	
6600	Fluorescent, RS, 4' long, ceiling mounted, two 40 watt		2.70	2.960		1,310	72		1,382	1,550	
6610	Three 40 watt		2.20	3.640		1,915	88		2,003	2,225	
6620	Four 40 watt		1.90	4.210		2,490	100		2,590	2,900	
6630	Pendent mounted, two 40 watt		2.30	3.480		1,390	84		1,474	1,650	
6640	Three 40 watt		1.90	4.210		2,020	100		2,120	2,375	
6650	Four 40 watt		1.70	4.710		2,570	115		2,685	3,000	
6700	Mercury vapor with ballast, surface mounted, 175 watt		2.70	2.960		545	72		617	705	
6710	250 watt		2.70	2.960		586	72		658	750	
6740	400 watt		2.40	3.330		714	81		795	905	
6750	Pendent mounted, 175 watt		2.40	3.330		550	81		631	725	
6760	250 watt		2.40	3.330		561	81		642	735	
6770	400 watt		2.10	3.810		683	92		775	885	
6780	Wall mounted, 175 watt		2.70	2.960		576	72		648	740	
6790	250 watt		2.70	2.960		632	72		704	800	
6820	400 watt		2.40	3.330		750	81		831	945	
6850	Vandalproof, surface mounted, fluorescent, two 40 watt		3.20	2.500		105	61		166	205	
6860	Incandescent, one 150 watt		8	1		45	24		69	85	
6900	Mirror light, fluorescent, RS, acrylic enclosure, two 40 watt		8	1		61	24		85	105	
6910	One 40 watt		8	1		56	24		80	97	
6920	One 20 watt		12	.667		49	16.15		65.15	78	
7000	Low bay, aluminum reflector, 70 watt, high pressure sodium		4	2		298	49		347	400	
7010	250 watt, high pressure sodium		3.20	2.500		535	61		596	680	
7020	400 watt, high pressure sodium		2.50	3.200		561	78		639	730	
7500	Ballast replacement, by weight of ballast, to 15' high										
7520	Indoor fluorescent, less than 2 lbs.	1 Elec	10	.800	Ea.		19.40		19.40	29	
7540	2 40W, watt reducer, 2 to 5 lbs.	"	9.40	.851	"	17	21		38	49	

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT RAAP Lighting Projects
AEP NO. 290 0379 000
SHEET 1 OF 10
DESIGNER T. Todd
DATE
CHECKER
DATE

GP-N-8 REPLACE INCANDESCENTS WITH COLOR-CORRECTED HPS SCREW-INS FOR EXPLOSION PROOF FIXTURES

Calculations were made on a per-unit basis for installing 50 W HPS color-corrected units within the existing explosion-proof incandescent fixtures. The per-unit calculations are on page 2. Only areas operating 3 shifts/day, 5 days/wk were considered. From the building survey data, a list of the buildings with potential incandescent lighting projects was compiled (page 3). It is assumed for this ECO that 90% of the interior fixtures are explosion proof and can be retrofitted in this manner. Exact dimensions of fixtures and screw-in retrofits should be verified.

Total fixtures = 0.9(1536) = 1382

Energy Savings = $499 \frac{\text{kwh}}{\text{yr}} \times 0.003413 \frac{\text{MBtu}}{\text{kwh}} \times 1382 \text{ fixtures} = 2354 \frac{\text{MBtu}}{\text{yr}}$

Energy cost savings = $\frac{\$15.11}{\text{yr-fixture}} \times 1382 = \$20,882/\text{yr}$

Matl & Labor Cost savings = $\frac{\$7.39}{\text{yr-fixt.}} \times 1382 = \$10,213/\text{yr}$

Total cost savings = 20,882 + 10,213 = \$31,095 /yr

Project cost = $\frac{\$118.65}{\text{fixture}} \times 1382 = \$163,974$

(Construction cost = \$163,974/1.115 = \$147,062)

Simple payback = $\frac{\$163,974}{\$31,095/\text{yr}} = 5.3$ yr

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT: RAAP Lighting Projects Screening Calcs.
DESIGNER: J. T. Todd
CHECKER:
AEP NO. 290 0379000
SHEET 2 OF 10
DATE
DATE

GP-N-8 Replace interior 150-200 W incandescents with 50 W HPS screw-in retrofits for explosion-proof applications

- Assume color rendition is important in this area, so the 50 W HPS (color-corrected) is chosen even though lumens exceed requirements.

$$\text{Energy savings} = (150\,W - 70\,W) \times 24\,\frac{hr}{day} \times 260\,\frac{days}{yr} = 499\,\frac{kwh}{yr}$$

$$\text{Energy cost savings} = 499\,\frac{kwh}{yr} \times \frac{\$0.03026}{kwh} = \frac{\$15.11}{yr}$$

$$\text{Labor + Mat'l cost savings} = \left(\frac{\text{Incand cost}}{750\,hr} - \frac{\text{HPS cost}}{12{,}000\,hr}\right) \times 6240\,\frac{hr}{yr}$$

$$= \left[\frac{(\$2.11\text{ mat'l} + \$1.20\text{ labor} \times 0.683 \times 1.2)}{750\,hr} - \frac{(\$30.00\text{ mat'l} + \$6.45\text{ labor} \times 0.683 \times 1.2)}{12{,}000\,hr}\right] \times 6240\,\frac{hr}{yr} = \frac{\$7.39}{yr}$$

$$\text{Total cost savings} = \frac{\$15.11}{yr} + \frac{\$7.39}{yr} = \frac{\$22.50}{yr}$$

Mat'l cost = \$ 67.00 for fixture w/lamp (1990 vendor info.)

Labor cost = \$1.20 × 1.20 retrofit × 1.2 exp-proof × 0.683 = \$1.18

$$\text{Project Cost} = [(1.045 \times \$67.00) + (1.2 \times \$1.18)] \times 1.661 = \$118.65$$

$$\text{Simple payback} = \frac{\$118.65}{\$22.50/yr} = 5.3\,yr < 10\,yr$$

Note: HPS lamps are replaceable in the retrofit ballasts.

Radford Army Ammunition Plant
List of Buildings with Incandescent Lighting

Bldg No	Name/Process	Location	Similar	Fixtures/Bldg.	Total Fixtures
1000 -00	Cotton Linter Warehouse	NC, A&B-Line	1	17	17
1606 -00	Open Tank Air Dry	Sol. Recovery, A-Line	10	20	200
1611 -00	Solvent Recovery House	Sol. Recovery, B-Line	27	12	324
3513 -00	C-1 Press & Cutting House	Green, C-Line	3	20	60
4912 -27	SG Curing Hse.- Carpet Rolls	Cast Prop. (Rocket)	10	5	50
4924 -06	Machine and Saw House	Cast Prop. (Rocket)	1	6	6
7106 -04	Dry House #4 (Cure Grain)	1st R P	7	8	56
9334 -15	Blender House	4th Rolled Powder	1	4	4
TOTAL FOR EXTERIOR FIXTURES					717
420 -02	Acid Waste Disposal (C-Line)	Waste Acid	1	8	8
2019 -00	Boiling Tub House	NC, B-Line	3	50	150
2022 -00	Beater House	NC, B-Line	3	40	120
2024 -00	Poacher & Blending House	NC, B-Line	3	30	90
3513 -00	C-1 Press & Cutting House	Green, C-Line	3	50	150
4912 -40	Forced Air Dry House	Pilot B	21	10	210
4912 -11	LG Mold Loading House	Cast Prop. (Rocket)	2	6	12
4912 -03	MK 43 Sawing and Inhibiting	Cast Prop. (Rocket)	1	4	4
4915 -00	Small Grain Mold Assembly	Cast Prop. (Rocket)	1	7	7
4921 -00	Inspect/Clean NG Tanks *	Cast Prop. (Rocket)	1	21	21
4951 -02	TOW Launch Saw House	Pilot B	1	8	8
5008 -01	15 Inch Press House	Pilot A	3	2	6
6304 -00	Paste Blending House	1st R P	1	20	20
7113 -00	Roll House (Rolled Powder)	1st R P (F-Line)	1	130	130
9310 -02	Rolled Powder Building	4th Rolled Powder	2	300	600
TOTAL FOR INTERIOR FIXTURES					1536

GP-N-8

CONSTRUCTION COST ESTIMATE

CONSTRUCTION COST ESTIMATE	DATE PREPARED 6/90	SHEET 4 OF 10

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: RADFORD ARMY AMMUNITION PLANT

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE:
- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.: GP-N-8 | ESTIMATOR: T. Todd | CHECKED BY:

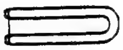
Incand. to 50W HPS SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
Replace incandescent lamps with 50 W HPS screw-in retrofits	1382	fixt.	1.18	1631	67.00	92594	94225
Sales Tax	4.5%					4167	4167
FICA / Insurance	20.0%			326			326
Subtotal				1957		96761	98718
Overhead	15.0%						14808
Profit	10.0%						11353
Performance Bond	1.0%						1249
Hercules Support	6.0%						7568
Contingency	10.0%						13370
Construction Cost							147066

ECP ENERGY CONSERVATION PRODUCTS, 511 CANAL STREET, NYC, NY, 10013—TEL (212)-925-5991

POWER CONSUMPTION AND LUMEN OUTPUT DATA

	WATTS	LINE WATTS	TOTAL LUMEN OUTPUT	LUMENS PER WATT	HOURS OF RATED LIFE
********* MERCURY VAPOR (DELUXE WHITE)					
*	1000	1075	63000	59	24000
*	400	450	23000	56	24000
*	250	290	13000	42	24000
*	175	205	8500	49	24000
*	100	120	4500	42	24000
*	75	93	3150	37	16000
*	50	61	1680	31	16000
********* METAL HALIDE					
*	1500	1600	155000	103	3000
*	1000	1100	110000	100	12000
*	400	460	34000	85	15000
*	175	210	14000	85	7500
********* HIGH PRESSURE SODIUM					
*	1000	1080	140000	130	24000
*	400	480	50000	104	24000
*	250	310	27500	89	24000
*	150	200	16000	80	24000
*	100	135	9500	70	24000
*	70	85	5800	68	24000
*	50	70	4000	57	24000
*	35	42	2850	67	18000
*********FLUORESCENT					
STRAIGHT	40	48	3150	66	20000+
CIRCLINE	32	37	1830	50	12000+
CIRCLINE	22	25	1050	42	12000+
CIRCLINE	20	23	850	37	12000+
TWIN TUBE	13	16	900	56	10000+
TWIN TUBE	9	12	600	50	10000+
STRAIGHT	8	11	400	36	7500+
TWIN TUBE	7	10	400	40	10000+
STRAIGHT	6	9	300	33	7500+
TWIN TUBE	5	8	250	31	10000+
********* INCANDESCENT					
*	1000	1000	23740	24	1000
*	750	750	17040	23	1000
*	500	500	10850	22	1000
*	200	200	3710	19	750
*	150	150	2880	19	750
*	100	100	1750	18	750
*	75	75	1190	16	750
********* QUARTS—IODINE					
*	1500	1500	35800	24	3000
*	1000	1000	23400	23	2000
*	500	500	10950	22	2600
*	250	250	4850	19	2000

RAPID START FLUORESCENT U LAMPS



LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
FB40/U6/CW/EW	34	2,600	12,000	12
FB40/U6/CW	40	2,950	12,000	12

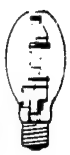
INSTANT START SLIMLINE FLUORESCENT LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
F72T12/CW	55	4,550	12,000	12
F96T12/CW/EW	60	5,600	15,000	15
F96T12/CW	75	6,200	12,000	15

HIGH & VERY HIGH OUTPUT FLUORESCENT LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
F96T12/CW/HO/EW	95	8,300	12,000	15
F96T12/CW/HO	110	9,200	12,000	15
F96T12/CW/VHO/EW	185	14,000	12,000	15
F96T12/CW/VHO	215	15,500	12,000	15

METAL HALIDE UNIVERSAL BURN MEDIUM BASE LAMPS



LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
MH35/U	35	2,300	5,000	12
MH50/U	50	3,400	5,000	12
MH70/U	70	5,500	5,000	12
MH100/U	100	7,200	7,500	12
MH150/U	150	12,000	10,000	12

METAL HALIDE UNIVERSAL BURN MOGAL BASE LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
MH175/U	175	14,000	10,000	12
MH175/C/U	175	14,000	10,000	12
MH250/U	250	20,500	10,000	12
MH250/C/U	250	20,500	10,000	12
MH400/U	400	36,000	20,000	6
MH400/C/U	400	36,000	20,000	6
MH1000/U	1000	110,000	12,000	6
MH1000/C/U	1000	105,000	12,000	6

COMPACT DOUBLE ENDED HQI METAL HALIDE LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
HQI 70	70	5,000	10,000	12
HQI 150	150	11,000	10,000	12
HQI 250	250	19,000	10,000	12
HQI 400	400	25,000	10,000	12

HIGH PRESSURE SODIUM MEDIUM BASE LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
LU35/MED	35	2,250	16,000	12
LU35/D/MED	35	2,150	16,000	12
LU50/MED	50	4,000	24,000	12
LU50/D/MED	50	3,800	24,000	12
LU70/MED	70	6,300	24,000	12
LU70/D/MED	70	5,985	24,000	12
LU100/MED	100	9,500	24,000	12
LU100/D/MED	100	8,800	24,000	12
LU150/MED	150	16,000	24,000	12
LU150/D/MED	150	15,000	24,000	12

COLOR IMPROVED HIGH PRESSURE SODIUM LAMP

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
NHT50SDX	50	2,500	12,000	12

HIGH PRESSURE SODIUM ED-23½ MOGUL BASE LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
LU50	50	4,000	24,000	12
LU50/D	50	3,800	24,000	12
LU70	70	6,300	24,000	12
LU70/D	70	5,985	24,000	12
LU100	100	9,500	24,000	12
LU100/D	100	8,800	24,000	12
LU150/55	150	16,000	24,000	12
LU150/55/D	150	15,000	24,000	12

HIGH PRESSURE SODIUM E-18 MOGUL BASE LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
LU200	200	22,000	24,000	12
LU250	250	29,000	24,000	12
LU250/D	250	26,000	24,000	12
LU310	310	37,000	24,000	12
LU400	400	50,000	24,000	12

LOW PRESSURE SODIUM LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
SOX10	10	1,000	9,000	20
SOX18	18	1,800	14,000	20
SOX35	35	4,800	18,000	12
SOX55	55	8,000	18,000	9
SOX90	90	13,500	18,000	9
SOX135	135	22,500	18,000	9
SOX180	180	33,000	18,000	9

MR16 LOW VOLTAGE 12V TUNGSTEN HALOGEN LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
ESX (N)	20	3,300	2,000	20
BAB (W)	20	460	2,000	20
EYR (N)	42	7,300	2,000	20
EYS (M)	42	2,500	2,000	20
EYP (W)	42	1,200	2,000	20
EXT (N)	50	9,150	3,000	20
EXZ (M)	50	3,000	3,000	20
EXN (W)	50	1,500	3,000	20
EYF (N)	75	11,500	3,500	20
EYJ (M)	75	4,500	3,500	20
EYC (W)	75	2,000	3,500	20

MR16 LINE VOLTAGE 120V MEDIUM BASE TUNGSTEN HALOGEN LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
M/JDR75W/N	75	6,300	2,000	12
M/JDR75W/M	75	3,500	2,000	12
M/JDR75W/W	75	2,100	2,000	12
M/JDR100/N	100	8,500	2,000	12
M/JDR100/M	100	4 500	2,000	12
M/JDR100/W	100	3,000	2,000	12

MR16 LINE VOLTAGE 120V INTERMEDIATE BASE TUNGSTEN HALOGEN LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
I/JDR75W/N	75	6,300	2,000	12
I/JDR75W/M	75	3,500	2,000	12
I/JDR75W/W	75	2,100	2,000	12
I/JDR100/N	100	8,500	2,000	12
I/JDR100/M	100	4 500	2,000	12
I/JDR100/W	100	3,000	2,000	12

TUNGSTEN HALOGEN LINE VOLTAGE MEDIUM BASE TUBULAR LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
64484/CL	75	1,200	2,000	15
64484/FR	75	1,140	2,000	15
64486/CL	100	1,600	2,000	15
64486/FR	100	1,520	2,000	15
64488/CL	150	2,760	2,000	15
64488/FR	150	2,622	2,000	15

TUNGSTEN HALOGEN LINE VOLTAGE DOUBLE ENDED LAMPS

LAMP	WATTAGE	APPX LUMENS	AVERAGE LIFE HRS.	STANDARD CASE QTY.
Q100T3/CL	100	1,600	200	12
Q150T3/CL	150	2,800	200	12
Q200T3/CL	200	3,600	200	12
Q300T3/CL	300	6,000	200	12
Q500T3/CL	500	11,000	200	12
Q1500T3/CL	1500	33,000	200	12

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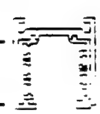
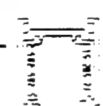
166 100 | Lighting

				DAILY	MAN-		BARE COSTS				TOTAL	
			CREW	OUTPUT	HOURS	UNIT	MAT.	LABOR	EQUIP.	TOTAL	INCL O&P	
140	1600	90 watt	1 Elec	.30	26.670	C	5,140	645		5,785	6,600	140
	1650	135 watt		.20	40		6,905	970		7,875	9,025	
	1700	180 watt		.20	40		7,308	970		8,278	9,475	
	1750	Quartz line, clear, 500 watt		1.10	7.270		1,872	175		2,047	2,325	
	1760	1500 watt		.20	40		3,427	970		4,397	5,200	
	1800	Incandescent, interior, A21, 100 watt		1.60	5		173	120		293	370	
	1900	A21, 150 watt		1.60	5		211	120		331	410	
	2000	A23, 200 watt		1.60	5		227	120		347	430	
	2200	PS 30, 300 watt		1.60	5		330	120		450	540	
	2210	PS 35, 500 watt		1.60	5		576	120		696	810	
	2230	PS 52, 1000 watt		1.30	6.150		1,525	150		1,675	1,900	
	2240	PS 52, 1500 watt		1.30	6.150		2,382	150		2,532	2,850	
	2300	R30, 75 watt		1.30	6.150		375	150		525	630	
	2400	R40, 150 watt		1.30	6.150		408	150		558	670	
	2500	Exterior, PAR 38, 75 watt		1.30	6.150		566	150		716	840	
	2600	PAR 38, 150 watt		1.30	6.150		525	150		675	795	
	2700	PAR 46, 200 watt		1.10	7.270		1,928	175		2,103	2,375	
	2800	PAR 56, 300 watt		1.10	7.270		2,193	175		2,368	2,675	
	3000	Guards, fluorescent lamp, 4' long		1	8		375	195		570	695	
	3200	8' long		.90	8.890		535	215		750	905	
145	0010	RESIDENTIAL FIXTURES										145
	0400	Fluorescent, interior, surface, circline, 32 watt & 40 watt	1 Elec	20	.400	Ea.	48	9.70		57.70	67	
	0500	2' x 2', two U 40 watt		8	1		66	24		90	110	
	0700	Shallow under cabinet, two 20 watt		16	.500		45	12.15		57.15	67	
	[illegible]00	Wall mounted, 4'L, one 40 watt, with baffle		10	.800		41	19.40		60.40	74	
	[illegible]0	Incandescent, exterior lantern, wall mounted, 60 watt		16	.500		36	12.15		48.15	57	
	2100	Post light, 150W, with 7' post		4	2		104	49		153	185	
	2500	Lamp holder, weatherproof with 150W PAR		16	.500		16	12.15		28.15	35	
	2550	With reflector and guard		12	.667		31	16.15		47.15	58	
	2600	Interior pendent, globe with shade, 150 watt		20	.400		78	9.70		87.70	100	
150	0010	TRACK LIGHTING										150
	0080	Track, 1 circuit, 4' section	1 Elec	6.70	1.190	Ea.	33	29		62	79	
	0100	8' section		5.30	1.510		48	37		85	105	
	0200	12' section		4.40	1.820		81	44		125	155	
	0300	3 circuits, 4' section		6.70	1.190		36	29		65	82	
	0400	8' section		5.30	1.510		48	37		85	105	
	0500	12' section		4.40	1.820		88	44		132	160	
	1000	Feed kit, surface mounting		16	.500		12	12.15		24.15	31	
	1100	End cover		24	.333		1.98	8.10		10.08	14.05	
	1200	Feed kit, stem mounting, 1 circuit		16	.500		16	12.15		28.15	35	
	1300	3 circuit		16	.500		16	12.15		28.15	35	
	2000	Electrical joiner for continuous runs, 1 circuit		32	.250		6.55	6.05		12.60	16.10	
	2100	3 circuit		32	.250		12.10	6.05		18.15	22	
	2200	Fixtures, spotlight, 150 PAR		16	.500		47	12.15		59.15	70	
	3000	Wall washer, 250 watt tungsten halogen		16	.500		101	12.15		113.15	130	
	3100	Low voltage, 25/50 watt, 1 circuit		16	.500		102	12.15		114.15	130	
	3120	3 circuit		16	.500		109	12.15		121.15	140	

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	166 100 | Lighting		CREW	DAILY OUTPUT	MAN-HOURS	UNIT	BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL O&P	
135	5100	175 watt metal halide	1 Elec	8	1	Ea.	479	24		503	565	135
	5110	250 watt metal halide		8	1		500	24		524	585	
	5120	150 watt high pressure sodium		8	1		535	24		559	625	
	5130	250 watt high pressure sodium		8	1		556	24		580	645	
	5140	72"H 18" sq., 400 watt metal halide		8	1		525	24		549	615	
	5150	250 watt high pressure sodium		8	1		556	24		580	645	
	5160	400 watt high pressure sodium		8	1		581	24		605	675	
	5190	Portable rectangle, 6" high 13.5" x 20"										
	5200	175 watt metal halide	1 Elec	12	.667	Ea.	293	16.15		309.15	345	
	5210	250 watt metal halide		12	.667		314	16.15		330.15	370	
	5220	150 watt high pressure sodium		12	.667		335	16.15		351.15	390	
	5230	250 watt high pressure sodium		12	.667		360	16.15		376.15	420	
	5240	8" high 18" x 24", 400 watt metal halide		12	.667		365	16.15		381.15	425	
	5250	250 watt high pressure sodium		12	.667		376	16.15		392.15	435	
	5260	400 watt high pressure sodium		12	.667		398	16.15		414.15	460	
	5270	Portable square, 15" high 13.5" sq., 175 watt metal halide		12	.667		324	16.15		340.15	380	
	5280	250 watt metal halide		12	.667		376	16.15		392.15	435	
	5290	150 watt high pressure sodium		12	.667		360	16.15		376.15	420	
	5300	250 watt high pressure sodium		12	.667		386	16.15		402.15	450	
	5400	Pendent 16" round/square, 175 watt metal halide		3.20	2.500		355	61		416	480	
	5410	250 watt metal halide		2.70	2.960		370	72		442	515	
	5420	400 watt metal halide		2.40	3.330		398	81		479	555	
	5430	150 watt high pressure sodium		3.20	2.500		398	61		459	525	
	5440	250 watt high pressure sodium		2.70	2.960		428	72		500	575	
	[illegible]50	400 watt high pressure sodium		2.40	3.330		454	81		535	620	
140	0010	LAMPS										140
	0080	Fluorescent, rapid start, cool white, 2' long, 20 watt	1 Elec	1	8	C	348	195		543	670	
	0100	4' long, 40 watt		.90	8.890		198	215		413	535	
	0120	3' long, 30 watt		.90	8.890		442	215		657	805	
	0150	U-40 watt		.80	10		874	245		1,119	1,325	
	0170	4' long, 35 watt energy saver		.90	8.890		270	215		485	615	
	0200	Slimline, 4' long, 40 watt		.90	8.890		618	215		833	995	
	0300	8' long, 75 watt		.80	10		577	245		822	990	
	0350	8' long, 60 watt energy saver		.80	10		603	245		848	1,025	
	0400	High output, 4' long, 60 watt		.90	8.890		750	215		965	1,150	
	0500	8' long, 110 watt		.80	10		775	245		1,020	1,200	
	0520	Very high output, 4' long, 110 watt		.90	8.890		1,285	215		1,500	1,725	
	0550	8' long, 215 watt		.70	11.430		1,285	275		1,560	1,825	
	0600	Mercury vapor, mogul base, deluxe white, 100 watt		.30	26.670		2,142	645		2,787	3,300	
	0650	175 watt		.30	26.670		1,663	645		2,308	2,775	
	0700	250 watt		.30	26.670		2,968	645		3,613	4,225	
	0800	400 watt		.30	26.670		2,340	645		2,985	3,525	
	0900	1000 watt		.20	40		5,100	970		6,070	7,025	
	1000	Metal halide, mogul base, 175 watt		.30	26.670		3,749	645		4,394	5,075	
	1100	250 watt		.30	26.670		4,712	645		5,357	6,125	
	1200	400 watt		.30	26.670		4,386	645		5,031	5,775	
	1300	1000 watt		.20	40		9,894	970		10,864	12,300	
	1320	1000 watt, 125,000 initial lumens		.20	40		9,960	970		10,930	12,400	
	1330	1500 watt		.20	40		9,268	970		10,238	11,600	
	[illegible]50	Sodium high pressure, 70 watt		.30	26.670		4,712	645		5,357	6,125	
	[illegible]0	100 watt		.30	26.670		4,871	645		5,516	6,300	
	1370	150 watt		.30	26.670		5,059	645		5,704	6,525	
	1380	250 watt		.30	26.670		5,380	645		6,025	6,875	
	1400	400 watt		.30	26.670		5,727	645		6,372	7,250	
	1450	1000 watt		.20	40		13,352	970		14,322	16,100	
	1500	Low pressure, 35 watt		.30	26.670		3,963	645		4,608	5,300	
	1550	55 watt		.30	26.670		4,386	645		5,031	5,775	

HUNTER **Telephone Call Confirmation**

Project No. 290 0379000

Local ______ L.D. (718) 851-1577 Placed ✓ Rec'd. ✓ Date 6-7-90

T. Todd Conversed With Mr. Singer

Of American Scientific Lighting Co. Regarding HPS retrofits

For retrofits of incandescent fixtures, the "Bulb Lumenight" and "Colorlight" products are recommended. The lamps are replaceable in both and the "colorlight" is more whitish. Contractors costs (including lamp) for quantities of 100+ are as follows:

Bulb Lumenight	35 W	$45	(lamps only
	50 W	$45	$16 - $20)

(also come in 70 W, 100 W, 150 W)

Colorlight	50 W	$67	(lamps only $30)

They will send a copy of their catalog for dimensions.

Distribution:

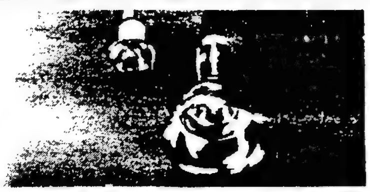
DOWNLITE™ CONVERSION SERIES: *COMPACT FLUORESCENT REFLECTOR LAMPS*

GLOBE FLECTOR™ LUMA FLECTOR™

- **LAMP:** Compact disposable fluorescent globe or tubular lamp/Standard or tapered base
- **REFLECTOR:** Highly polished aluminum
- **WATTAGE:** Fifteen
- **LUMENS:** 1350
- **COLOR:** Warm white/2800k
- **USE:** Indoor only
- **BURNING POSITION:** Any
- **LAMP LIFE:** 9,000 hours
- **INSTALLATION:** Screws into any 120V medium base socket
- **PACKAGING:** Ten conversions per carton

CATALOG NUMBER	LAMP	DIMENSIONS
DGF S/15	BFG15 LE/A	Reflector Diameter 5⅛" Overall Length 6¼"
DGF T/15	BFG15 LE/T	Reflector Diameter 5⅛" Overall Length 6¾"
DLF S/15	BFT15 LE/A	Reflector Diameter 5⅛" Overall Length 6⅜"
DLF T/15	BFT15 LE/T	Reflector Diameter 5⅛" Overall Length 7"

LINE VOLTAGE/LOW VOLTAGE *MR16 HALOGEN CONVERSIONS*



HALOGENLITE™ 120V

- **LAMP:** MR16 Dichro-Cool tungsten halogen/Medium base or intermediate with medium adapter base and clip on lens/Line voltage/Cool crisp white light 3000k/Dimmable up to twenty five percent/Medium beam spread.
- **LAMP LIFE:** 2,000 hours/High lumen maintenance
- **INSTALLATION:** Screws directly into any ventilated 120V medium base porcelin socket rated above 100 watt/Minimum front diameter opening 4¾"
- **PACKAGING:** Ten lamps per carton

CATALOG NUMBER	LAMP	DIMENSIONS
MEDIUM		
DH 120 M/75	JDR75	Lamp Diameter 2"
DH 120 M/100	JDR100	Overall Length 2 5/16"
INTERMEDIATE		
DH 120 I/75	JDR75	Lens Diameter 2⅛"
DH 120 I/100	JDR100	Overall Length 5⅜"

OPTIONS:
R Reflector
N Narrow Beam Spread 10°
M Medium Beam Spread 18°
W Wide Beam Spread 28°

HALOGENLITE™ 12V

- **ADAPTER:** Molded Valox® plastic/Vented to cool internal components
- **FINISH:** Black
- **LAMP:** MR16 Dichro-Cool tungsten halogen/Low voltage/Stepdown transformer/Dimmable/Cool crisp white light 3000k/Natural sunlight appearance
- **LIFE:** 2000 hours – 20 watt/3000 hours – 50 watt
- **INSTALLATION:** DH 12/20 screws into any medium base porcelin socket rated for 75 watts/DH 12/50 into socket rated for 150 watts
- **PACKAGING:** Four conversions per carton/Lamp included

CATALOG NUMBER	LAMP	DIMENSIONS
DH 12/20	JR/20	Adapter Diameter 3¼"
DH 12/50	JR50	Overall Length 6"
DH 12/20/R40	JR/20	Adapter Diameter 3¼"
DH 12/50/R40	JR/50	Overall Length 7¾" Lens Diameter 5"

OPTIONS:
BAB Flood/20w
ESX Narrow Spot/20w
EXT Narrow Spot/50w
EXZ Narrow Flood/50w
EXN Flood/50w

COLOR IMPROVED *HPS HIGH HAT CONVERSION*

COLORLITE 50™

- **ADAPTER:** Heavy gauge spun aluminum
- **FINISH:** Caustic etching
- **REFLECTOR:** Highly polished aluminum/Vented slots for cool operation
- **LAMP COLOR:** 2500K • **LAMP LIFE:** 12000 Hours
- **INSTALLATION:** Adapter screws into a standard 120V high hat fixture/Medium base porcelain socket required/Fixture rated for a minimum of 150 watts/Minimum front diameter opening 5"
- **PACKAGING:** Four conversions per carton/Lamp included

CATALOG NUMBER	LAMP	DIMENSIONS
DC/50	NHT50 SDX	Adapter Diameter 3⅛" Reflector Diameter 5¼" Overall Height 8½"

AMERICAN SCIENTIFIC LIGHTING CORPORATION • BROOKLYN, NEW YORK • TEL. (800) 552-3465 • (718) 851-4577 • FAX (718) 853-2390

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT RAAP Lighting Projects
Screening Calcs

AEP NO. 290 0379 000

SHEET 1 OF 2

DESIGNER T. Todd

DATE

CHECKER

DATE

ECO # GP-N-9

Replace all 40 W fluorescent lamps with 34 W fluorescents upon failure *

- Assume no add'l labor costs are incurred since lamps would be replaced anyway.

$$\text{Energy savings} = \frac{6\ W}{\text{lamp}} \times \frac{24\ hr}{day} \times \frac{260\ days}{yr} = 37.4\ \frac{kwh}{yr} \quad 0.128\ MBtu/yr$$

$$\text{Cost savings} = 37.4\ \frac{kwh}{yr} \times \frac{\$0.03026}{kwh} = \frac{\$1.13}{yr}$$

Mat'l cost = cost of 34W fluor. − cost of 40W fluor.
= $2.70 − $1.98 = $0.72

Project cost = $0.72 × 1.045 = $0.75 / lamp

$$\text{Simple payback} = \frac{\$0.75}{\$1.13/yr} = 0.7\ yr$$

$$\text{Life of lamp} = 20{,}000\ hr \times \frac{yr}{6240\ hr} = 3.2\ yr > 0.7\ yr$$

GP-N-9 p. 2 of 2

166 100 | Lighting

		Description	Crew	Daily Output	Man-Hours	Unit	Bare Costs Mat.	Bare Costs Labor	Bare Costs Equip.	Bare Costs Total	Total Incl O&P	
135	5100	175 watt metal halide	1 Elec	8	1	Ea.	479	24		503	565	135
	5110	250 watt metal halide		8	1		500	24		524	585	
	5120	150 watt high pressure sodium		8	1		535	24		559	625	
	5130	250 watt high pressure sodium		8	1		556	24		580	645	
	5140	72"H 18" sq., 400 watt metal halide		8	1		525	24		549	615	
	5150	250 watt high pressure sodium		8	1		556	24		580	645	
	5160	400 watt high pressure sodium		8	1		581	24		605	675	
	5190	Portable rectangle, 6" high 13.5" x 20"										
	5200	175 watt metal halide	1 Elec	12	.667	Ea.	293	16.15		309.15	345	
	5210	250 watt metal halide		12	.667		314	16.15		330.15	370	
	5220	150 watt high pressure sodium		12	.667		335	16.15		351.15	390	
	5230	250 watt high pressure sodium		12	.667		360	16.15		376.15	420	
	5240	8" high 18" x 24", 400 watt metal halide		12	.667		365	16.15		381.15	425	
	5250	250 watt high pressure sodium		12	.667		376	16.15		392.15	435	
	5260	400 watt high pressure sodium		12	.667		398	16.15		414.15	460	
	5270	Portable square, 15" high 13.5" sq., 175 watt metal halide		12	.667		324	16.15		340.15	380	
	5280	250 watt metal halide		12	.667		376	16.15		392.15	435	
	5290	150 watt high pressure sodium		12	.667		360	16.15		376.15	420	
	5300	250 watt high pressure sodium		12	.667		386	16.15		402.15	450	
	5400	Pendent 16" round/square, 175 watt metal halide		3.20	2.500		355	61		416	480	
	5410	250 watt metal halide		2.70	2.960		370	72		442	515	
	5420	400 watt metal halide		2.40	3.330		398	81		479	555	
	5430	150 watt high pressure sodium		3.20	2.500		398	61		459	525	
	5440	250 watt high pressure sodium		2.70	2.960		428	72		500	575	
	5450	400 watt high pressure sodium		2.40	3.330		454	81		535	620	
140	0010	LAMPS										140
	0080	Fluorescent, rapid start, cool white, 2' long, 20 watt	1 Elec	1	8	C	348	195		543	670	
	0100	4' long, 40 watt		.90	8.890		198	215		413	535	
	0120	3' long, 30 watt		.90	8.890		442	215		657	805	
	0150	U-40 watt		.80	10		874	245		1,119	1,325	
	0170	4' long, 35 watt energy saver		.90	8.890		270	215		485	615	
	0200	Slimline, 4' long, 40 watt		.90	8.890		618	215		833	995	
	0300	8' long, 75 watt		.80	10		577	245		822	990	
	0350	8' long, 60 watt energy saver		.80	10		603	245		848	1,025	
	0400	High output, 4' long, 60 watt		.90	8.890		750	215		965	1,150	
	0500	8' long, 110 watt		.80	10		775	245		1,020	1,200	
	0520	Very high output, 4' long, 110 watt		.90	8.890		1,285	215		1,500	1,725	
	0550	8' long, 215 watt		.70	11.430		1,285	275		1,560	1,825	
	0600	Mercury vapor, mogul base, deluxe white, 100 watt		.30	26.670		2,142	645		2,787	3,300	
	0650	175 watt		.30	26.670		1,663	645		2,308	2,775	
	0700	250 watt		.30	26.670		2,968	645		3,613	4,225	
	0800	400 watt		.30	26.670		2,340	645		2,985	3,525	
	0900	1000 watt		.20	40		5,100	970		6,070	7,025	
	1000	Metal halide, mogul base, 175 watt		.30	26.670		3,749	645		4,394	5,075	
	1100	250 watt		.30	26.670		4,712	645		5,357	6,125	
	1200	400 watt		.30	26.670		4,386	645		5,031	5,775	
	1300	1000 watt		.20	40		9,894	970		10,864	12,300	
	1320	1000 watt, 125,000 initial lumens		.20	40		9,960	970		10,930	12,400	
	1330	1500 watt		.20	40		9,268	970		10,238	11,600	
	1350	Sodium high pressure, 70 watt		.30	26.670		4,712	645		5,357	6,125	
	1360	100 watt		.30	26.670		4,871	645		5,516	6,300	
	1370	150 watt		.30	26.670		5,059	645		5,704	6,525	
	1380	250 watt		.30	26.670		5,380	645		6,025	6,875	
	1400	400 watt		.30	26.670		5,727	645		6,372	7,250	
	1450	1000 watt		.20	40		13,352	970		14,322	16,100	
	1500	Low pressure, 35 watt		.30	26.670		3,963	645		4,608	5,300	
	1550	55 watt		.30	26.670		4,386	645		5,031	5,775	

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT RAAP Lighting Projects Screening Calcs
DESIGNER T. Todd
CHECKER
AEP NO 290 0379000
SHEET 1 OF 3
DATE
DATE

ECO # GP-N-10

Replace all standard efficiency fluorescent ballasts with high efficiency ballasts upon failure

- Assume no additional labor costs would be incurred since ballasts would be replaced anyway.
- Assume 2 lamps per ballast for 4' fixtures.

$$\text{Energy savings} = [96-2(40)] - [71-2(34)]\ W = 13\ W/\text{fixture}$$

$$= \frac{13\ W}{\text{fixture}} \times \frac{24\ hr}{day} \times \frac{260\ days}{yr} = 81\ \frac{kwh}{yr}\ \text{per fixture}$$

$$\text{Cost savings} = 81\ \frac{kwh}{yr} \times \frac{\$0.03026}{kwh} = \frac{\$2.45}{yr}\ \text{per fixture}$$

Mat'l cost = cost of energy efficient ballast − cost of standard ballast

$$= (\$21.94 - \$15.86) \times 1.05\ \text{inflation} = \$6.38$$

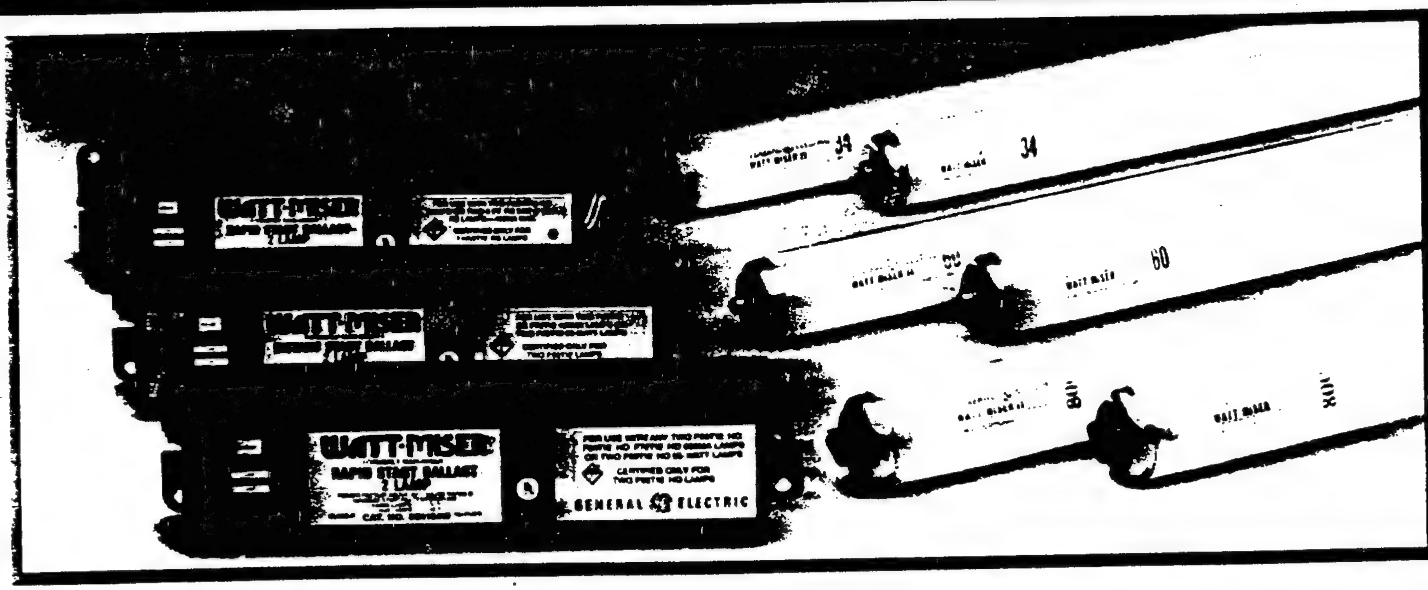
$$\text{Project cost} = \$6.38 \times 1.045 = \$6.67$$

$$\text{Simple payback} = \frac{\$6.67}{\$2.45/yr} = 2.7\ yr$$

$$\text{Life of ballast} \cong 24\ yr > 2.7\ yr\ \text{payback}$$

GP-N-10 p.2 of 3

GE WATT-MISER™ BALLASTS USE LESS WATTS PER FIXTURE TO DELIVER HIGH ENERGY SAVINGS



Watt-Miser Ballasts

- Compatible with standard or energy-saving lamps (3-lamp WM ballast compatible only with ES lamps)
- Cooler operation extends ballast life
- Dimensionally interchangeable with standard ballasts.
- CBM-certified by ETL with standard lamps. (3-lamp WM ballast not CBM certified)
- UL-listed, Class P.

The GE Watt-Miser ballast is inherently more energy-efficient than a standard ballast. Even greater savings come from pairing Watt-Miser ballasts with today's popular reduced-wattage lamps. Watt-Miser ballasts are offered for 4′ Rapid Start; 8′ Instant Start; and 8′ High Output applications. A 3-lamp Watt-Miser ballast in a standard rapid start case is available for use with four-foot energy-saving lamps. The chart shows fixture watts and energy $ that can be saved by replacing standard lamps and ballasts with Watt-Miser ballasts and energy-saving lamps.

Lamp Ballast System Replacement Chart

Fluorescent Fixture Type	Standard System[1] Lamp Type	Standard System[1] Watts Per Fixture	Watt-Miser System Lamp Type[2]	Watt-Miser System Watt-Miser Ballast[4]	Watt-Miser System Watts Saved Per Fixture	Energy[3] $ Saved Per Fixture
4-LAMP TROFFER	F40 F40 (34W)	181 159	F40LW/RS/WMII F40LW/RS/WMII	(2)8G1024W (2)8G1024W	41 19	$ 9.84 $ 4.56
3-LAMP TROFFER	F40	149	F40LW/RS/WMII	(1)8G1024W and (1)8G1074W (1)8G1324W	40 43	$ 9.60 $10.32
2-LAMP INDUSTRIAL	F40 F96T12 F96T12/HO	96 172 255	F40LW/RS/WMII F96T12/LW/WMII F96T12/LW/HO/WMII	8G1024W 8G1004W 8G1154W	25 46 56	$ 6.00 $16.56 $20.16
2-LAMP, SURFACE-MOUNT, WRAP AROUND	F40	82	F40LW/RS/WMII	8G1024W	16	$ 3.36
4-LAMP, SURFACE-MOUNT, WRAP AROUND	F40	165	F40LW/RS/WMII	(2)8G1024W	32	$ 6.72

(1) Fixture equipped with standard ballast and lamp shown.
(2) Other energy-saving lamps may be used to obtain similar savings.
(3) Annual energy savings at 8¢ KWH; 3000 Hrs.—F40; 4500 Hrs.—F96.
(4) Ballast codes shown are 120-volt. For complete application information, see product tables.

Project No. 87-210-08
PTAC No. 865911

Telephone Call Confirmation

reynolds, smith and hills

Local 396-7446 L.D. (813) Tampa 988-7351 Placed ✓ Rec'd ______ Date 5-27-87

T. Masters Conversed with Stan Jetson / Joe Howley

Of G. E. Lamp Marketing / Engineering Regarding ballasts

Stan Jetson provided costs, Joe Howley provided wattages, light output, lifetimes

4 ft			Cost	Life (function of heat)
Standard	8G1022WF	(S)	$15.86	10-12 yr
Wattmiser	8G1024 WF	(W)	$21.94	24 yr
Maximiser II	8G1028WF	(M)	$22.89	24 yr (energy-efficient)
Optimiser	M28-120F	(O)	$34.10	30 yr

- Maximiser II – patented, full light output using energy saving lamp; may be able to delamp with this one
- Optimiser – patented, newest; lowest wattage input

8 ft				
Standard	8G1011WF	(S)	$25.90	12 yr
Wattmiser	8G1004 WF	(W)	$36.86	24 yr
Maximiser II	8G1008WF	(M)	$39.17	24 yr

Distribution:

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT: RAAP EAAP
Install Strip Curtains
DESIGNER: W. T. Todd
CHECKER: ØK

AEP NO: 290-0379-000
SHEET: 1 OF
DATE: 6-11-90
DATE:

ECO # GP-W-1

INSTALL VINYL STRIP CURTAINS

Assumptions:

1. The average outdoor air temperature is 45°F.

2. The indoor design temperature is 75°F.

3. Average wind speed is 9 knots according to the Facility Design and Planning, Engineering Weather Data, Department of the Army Technical Manual. Assume the average wind speed at the door openings is 3 miles per hour.

4. Assume a door opening of 8 feet by 8 feet, and the door(s) are open for 1 shift per day.

Calculations:

$$Q_{loss} = \dot{m}\, C_p\, \Delta T$$

$$\dot{m} = 3\,\frac{miles}{hr} \times \frac{5280\,ft}{mi} \times 8ft \times 8ft \times \frac{1\,lb}{13.5\,ft^3} = 75{,}093\ ^{lb}/_{hr}$$

$$C_p = 0.24\ ^{Btu}/_{lb\text{-}°F}$$

$$\Delta T = 75°F - 45°F = 30°F$$

$$Q_{loss} = 75{,}093\,\frac{lb}{hr} \times 0.24\,\frac{Btu}{lb°F} \times 30°F = 0.5\,\frac{MBtu}{hr}$$

The savings occur $8760\frac{hr}{yr} \times \frac{4\,mo}{12\,mo} \times \frac{8\,hr}{24\,hr} = 973$ hours per year if utilized for the months of December - March when the normal daily mean temperature is 41°F.

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT: RAAP EEAP
Install Strip Curtains
DESIGNER: W.T. Todd
CHECKER: A

AEP NO
SHEET 2 OF
DATE
DATE

GP-W-1
Calculations (continued):

Steam Savings:

0.5 MBtu/hr × 973 hr/yr × 25 bldgs = 12,162.5 MBtu/yr

Coal Savings:

12,162.5 MBtu/yr * 1.32 = 16,055 MBtu/yr

16,055 MBtu/yr × $1.61 /MBtu = 25,849 /yr

Elec. Price Diff. Costs

12,163 MBtu/yr * $1.11 = $13,501/yr

Project Cost:

Construction Cost = $18,247 See Cost Estimate Sheet

Simple Payback:

Payback = Cost ÷ Savings

= $18,247 ÷ ($25,849/yr − $13501/yr)

= $18247 ÷ $12,348/yr = 1.5 year

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT RAAP EEAP
Install Strip Curtains
DESIGNER W. T. Todd
CHECKER [illegible]

AEP NO
SHEET 3 OF
DATE
DATE

Buildings Identified During Survey With Potential For Utilization Of Clear Vinyl Strip Curtains.

Area	No. Bldgs.	Typ. Bldg. No.	Building Name
Sol. Rec.	15	1611-00	Solvent Recovery
NC-B & C	2	2010-00	Dry House & Conveyor
NC-B & C	2	2026-00	Final Wringer House
1st RP	1	7113-00	Roll House
4th RP	4	9309-04	Rolled Powder
Rocket	1	4924-01	Motor Load House
Total	25		

CONSTRUCTION COST ESTIMATE	DATE PREPARED 6-12-90	SHEET 4 OF

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: RADFORD ARMY AMMUNITION PLANT

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE:
- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.: NA | ESTIMATOR: W.T. Todd | CHECKED BY: [illegible]

Strip Curtains SUMMARY	QUANTITY NO. UNITS	UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
8'x8' Vinyl Strip Door	1	Ea.	100	100.00	354	354.00	454.00
Sales Tax				—	4.5%	15.93	15.93
FICA / Insurance			20%	20.00		—	20.00
Subtotal							489.93
Overhead	15%						73.49
Profit	10%						56.34
Performance Bond	1%						6.20
Hercules Support	6%						37.56
Contingency	10%						66.35
Subtotal							729.87
x 25 Buildings							x25
Construction Cost							$18,246.75

Source: Grainger Catalog, 1988, pg. 820, Increased by 5% per year for 1989 and 1990. Labor was assumed to take 4 manhours at $25 per hour.

ENG FORM 150 1 AUG 59 (ER 1110-345-730) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

RS&H

SUBJECT ______ | AEP NO ______
SHEET ______ OF ______
DESIGNER G. FALLON | DATE 6/14/90
CHECKER P. HUTCHINS | DATE 6/14/90

ECO# GP-X-1 REDUCE EXIT GAS TEMP. IN INCINERATOR COMBUSTION PROGRAM

THE COMBUSTION PROGRAM WAS ADAPTED TO DETERMINE EXIT GAS HEAT LOSS BY ZEROING THOSE INPUT PARAMETERS APPLICABLE TO BOILERS. THE "INPUT" PAGE SHOWS THE VALUES THAT WERE ZEROED.

THE INCINERATOR RECEIVES 3.9 gpm (≈2000 LBS/HR) OF WATER. THE OIL FLOW WAS ITERATED UNTIL THE HEAT ADDED EQUALLED THE HEAT LOST IN THE 500° EXIT GASES. AT THIS POINT THE MASS & ENERGY FLOWS BALANCE.

TO GENERATE THE GRAPH, THE EXIT GAS TEMPERATURE WAS INCREASED IN 100° INCREMENTS. THE PROGRAM CALCULATES THE HEAT CONTENT OF THE COMBUSTION PRODUCTS (ENERGY LOSS) FOR EACH EXIT TEMPERATURE. THE ENERGY LOSSES WERE THEN ANNUALIZED AND ADJUSTED FOR INCINERATOR LOAD FACTOR AS FOLLOWS:

<u>ANNUAL ENERGY LOSS @ 500°F EGT</u>

ENERGY LOSS FROM PAGE 2 IS 2.88 MBTU/HR
INCINERATOR DATA INDICATES A 50% LOAD FACTOR.

2.88 MBTU/hr. × 8760 HR/yr × .5 = 12614 MBTU/yr

BUT THIS IS BASE OF GRAPH SO 12614 − 12614 = 0

0 = GRAPH VALUE

<u>ANNUAL ENERGY LOSS @ 1400°F EGT</u>

ENERGY LOSS FROM PAGE 5 IS 4.97 MBTU/HR

4.97 MBTU/HR × 8760 × .5 = 21768 MBTU

<u>ENERGY SAVINGS</u>

RELATIVE TO 500°F BASE → 21768 − 12614 = 9154 MBTU/yr = GRAPH VALUE. [illegible] 13,558 MBTU/[illegible]

ADIABATIC FLAME TEMPERATURE &
COMBUSTION CALCULATIONS

****
INPUT- INPUT- INPUT- INPUT- INPUT- INPUT-
****

CLIENT	COE	DATE	14-Jun-90
PLANT	RAAP	TIME	12:44 PM

FUEL ULTIMATE ANALYSIS

CONSTITUENT	WT.PCT.	DRY FUEL RECEIVED	DRY & ASH FREE	ADJUSTED FUEL
CARBON	9.85	86.40	86.40	86.40
HYDROGEN	1.45	12.70	12.70	12.70
OXYGEN	0.01	0.10	0.10	0.10
NITROGEN	0.01	0.10	0.10	0.10
SULFUR	0.08	0.70	0.70	0.70
CHLORINE	0.00	0.00	0.00	0.00
WATER	88.60	0.00	0.00	0.00
INERTS	0.00	0.00	0.00	0.00
TOTAL	100.00	100.00	100.00	100.00

FUEL RATE (TONS/DAY)	27
TOTAL AIR ASSIGNED (%)	115
FUEL HIGHER HEATING VALUE (BTU/LB)	1274
HEAT LOSS DUE TO UNBURNED CARBON (%)	0.00
CARBON IN RESIDUE (%)	0.00
EXIT GAS TEMPERATURE (Deg. F)	500
AMBIENT DRY BULB TEMP (Deg.F)	80
HUMIDITY RATIO (LBS H2O/LB DRY AIR)	0.0132
BAROMETRIC PRESSURE (IN.Hg.)	29.92
RADIATION LOSS (%)	0.00
UNACCOUNTABLE LOSS (%)	0.00
ENTHALPY ADDED IN BOILER (BTU/LB)	0

ADIABATIC FLAME TEMPERATURE &
COMBUSTION CALCULATIONS

****
O U T P U T-O U T P U T-O U T P U T-O U T P U T-O U T P U T-O U T P U T-
****

CLIENT	COE	DATE	14-Jun-90
PLANT	RAAP	TIME	12:44 PM

HEAT LOSSES	MMBTU/HR	PERCENT
IN DRY FLUE GAS	0.44	15.40
FROM H2O IN AIR	0.00	-0.08
FROM H2O IN FUEL--SENSIBLE	-0.09	-3.15
FROM H2O IN FUEL--LATENT	2.53	87.83
TOTAL IN WET FLUE GAS	2.88	100.00
DUE TO UNBURNED CARBON	0.00	0.00
DUE TO HOT ASH	0.00	0.00
DUE TO RADIATION & UNACCOUNTABLE	0.00	0.00
TOTAL	2.88	100.00

BOILER EFFICIENCY (%)	0.00
STEAM GENERATED (LBS/HR)	ERR
UNBURNED CARBON (LBS/HR)	0
LBS OF WET FLUE GAS PER LB FUEL	2.90
SPEC.VOL.OF WET FLUE GAS (CU.FT./LB)	28.72
AIR TO FUEL RATIO (LB AIR/LB FUEL)	1.88
COMB. AIR SPECIFIC VOL. (CU.FT/LB)	13.712
COMBUSTION AIR FLOW (LBS/HR)	4295

F L U E G A S A N A L Y S I S

	% BY VOLUME		% BY WEIGHT	
	WET	DRY	WET	DRY
CO2	6.89	13.39	12.43	19.38
SO2	0.0209	0.0406	0.0549	0.0856
O2	1.49	2.89	1.95	3.04
HCL	0.0000	0.0000	0.0000	0.0000
N2	43.08	83.68	49.72	77.49
H2O	48.52		35.83	

F L U E   G A S   F L O W S

	WET	DRY
MASS (LBS/HR)	6552	4204
VOLUME (ACFM)	3137	1615
(SCFM)(70DEG.F.)	1732	891
@ 12% CO2	995	995
"F" FACTOR (DSCF/MMBTU @12% CO2)		20749

ADIABATIC FLAME TEMPERATURE &
COMBUSTION CALCULATIONS

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CLIENT	COE	DATE	14-Jun-90
PLANT	RAAP	TIME	12:46 PM

FUEL ULTIMATE ANALYSIS

CONSTITUENT	WT.PCT.	DRY FUEL RECEIVED	DRY & ASH FREE	ADJUSTED FUEL
CARBON	9.85	86.40	86.40	86.40
HYDROGEN	1.45	12.70	12.70	12.70
OXYGEN	0.01	0.10	0.10	0.10
NITROGEN	0.01	0.10	0.10	0.10
SULFUR	0.08	0.70	0.70	0.70
CHLORINE	0.00	0.00	0.00	0.00
WATER	88.60	0.00	0.00	0.00
INERTS	0.00	0.00	0.00	0.00
TOTAL	100.00	100.00	100.00	100.00

FUEL RATE (TONS/DAY)	27
TOTAL AIR ASSIGNED (%)	115
FUEL HIGHER HEATING VALUE (BTU/LB)	1274
HEAT LOSS DUE TO UNBURNED CARBON (%)	0.00
CARBON IN RESIDUE (%)	0.00
EXIT GAS TEMPERATURE (Deg. F)	1400
AMBIENT DRY BULB TEMP (Deg.F)	80
HUMIDITY RATIO (LBS H2O/LB DRY AIR)	0.0132
BAROMETRIC PRESSURE (IN.Hg.)	29.92
RADIATION LOSS (%)	0.00
UNACCOUNTABLE LOSS (%)	0.00
ENTHALPY ADDED IN BOILER (BTU/LB)	0

ADIABATIC FLAME TEMPERATURE &
COMBUSTION CALCULATIONS

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CLIENT	COE	DATE	14-Jun-90
PLANT	RAAP	TIME	12:46 PM

HEAT LOSSES	MMBTU/HR	PERCENT
IN DRY FLUE GAS	1.46	50.59
FROM H2O IN AIR	0.02	0.82
FROM H2O IN FUEL--SENSIBLE	0.97	33.62
FROM H2O IN FUEL--LATENT	2.53	87.83
TOTAL IN WET FLUE GAS	4.97	172.86
DUE TO UNBURNED CARBON	0.00	0.00
DUE TO HOT ASH	0.00	0.00
DUE TO RADIATION & UNACCOUNTABLE	0.00	0.00
TOTAL	4.97	172.86

BOILER EFFICIENCY (%)	-72.86
STEAM GENERATED (LBS/HR)	ERR
UNBURNED CARBON (LBS/HR)	0
LBS OF WET FLUE GAS PER LB FUEL	2.90
SPEC.VOL.OF WET FLUE GAS (CU.FT./LB)	55.65
AIR TO FUEL RATIO (LB AIR/LB FUEL)	1.88
COMB. AIR SPECIFIC VOL. (CU.FT/LB)	13.712
COMBUSTION AIR FLOW (LBS/HR)	4295

F L U E   G A S   A N A L Y S I S

	% BY VOLUME		% BY WEIGHT	
	WET	DRY	WET	DRY
CO2	6.89	13.39	12.43	19.38
SO2	0.0209	0.0406	0.0549	0.0856
O2	1.49	2.89	1.95	3.04
HCL	0.0000	0.0000	0.0000	0.0000
N2	43.08	83.68	49.72	77.49
H2O	48.52		35.83	

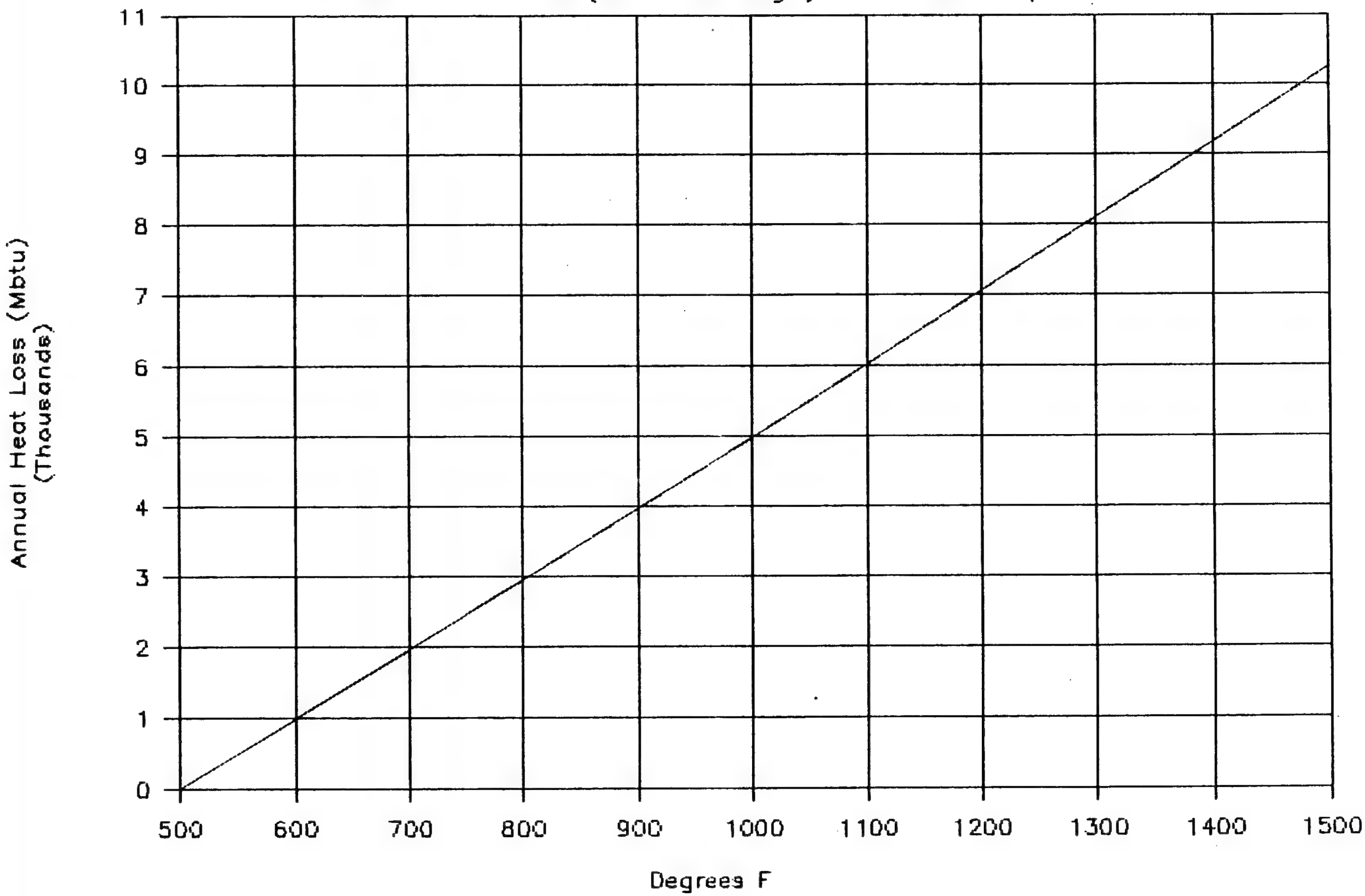
FLUE GAS FLOWS

	WET	DRY
MASS (LBS/HR)	6552	4204
VOLUME (ACFM)	6077	3129
(SCFM)(70DEG.F.)	1732	891
@ 12% CO2	995	995
'F' FACTOR (DSCF/MMBTU @12% CO2)		20749

6

Radford Army Ammunition Plant

Annual Heat Loss (above 500 Deg.F) vs Exit Gas Temp.



RS&H®

SUBJECT ______

AEP NO ______

SHEET ______ OF ______

DESIGNER G. FALLON DATE 6/14/90

CHECKER D. Hutkins DATE 6/14/90

ECO # GP-X-2 REDUCE WATER FLOW INTO INCINERATOR

Combustion Program

The combustion program was adapted to eliminate boiler absorbtions of heat by zeroing the appropriate parameters. Those are shown on the "INPUT" pages of the enclosed runs.

The incinerator evaporates 2000 LBS/HR of water. The fuel flow necessary to accomplish that while maintaining a 1000°F exit gas temperature was determined by iteration. This relationship was subsequently maintained for the remaining computer runs.

The graph was generated by varying the water flow (and therefore fuel flow) while maintaining the 1000°F exit gas temperature.

ENERGY LOSS AT 2000 LBS/HR H_2O

COMPUTER SHEETS

Energy loss from ~~PAGE 2~~ = 4.45 MBTU/HR

ENERGY LOSS AT 1800 LBS/HR H_2O

COMPUTER SHEETS

ENERGY LOSS FROM ~~PAGE 3~~ = 4.00 MBTU/HR

ANNUAL ENERGY SAVED FROM EACH INCINERATOR

DATA SHOWS 50% INCINERATOR LOAD FACTOR

$(4.45 - 4.00)$ mbtu/HR x 8760 hr/yr x .5 = 1971 MBTU/yr

ENERGY SAVINGS FOR BOTH INCINERATORS

1971 MBTU/yr x 2 = 3942 MBTU/yr

RS&H®

SUBJECT ______ AEP NO ______

SHEET ______ OF ______

DESIGNER PfH DATE 10/29/90

CHECKER ______ DATE ______

For QRIP

Current energy use for 1 incinerator

From Table 2-1 annual fuel oil bill is

\$343,763 (Other, #2 fuel oil)

For one incinerator

\$343,763/2 = \$171,882/yr.

Savings for one incinerator hydroclone is

3942/2 = 1971 MBtu fuel oil

Value of savings =

1971 * \$4.27 = \$8416/yr.

ADIABATIC FLAME TEMPERATURE &
COMBUSTION CALCULATIONS

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CLIENT	COE	DATE	14-Jun-90
PLANT	RAAP	TIME	12:31 PM

FUEL ULTIMATE ANALYSIS

CONSTITUENT	WT.PCT.	DRY FUEL RECEIVED	DRY & ASH FREE	ADJUSTED FUEL
CARBON	12.48	86.40	86.40	86.40
HYDROGEN	1.83	12.70	12.70	12.70
OXYGEN	0.01	0.10	0.10	0.10
NITROGEN	0.01	0.10	0.10	0.10
SULFUR	0.10	0.70	0.70	0.70
CHLORINE	0.00	0.00	0.00	0.00
WATER	85.56	0.00	0.00	0.00
INERTS	0.00	0.00	0.00	0.00
TOTAL	100.00	100.00	100.00	100.00

FUEL RATE (TONS/DAY)	28
TOTAL AIR ASSIGNED (%)	115
FUEL HIGHER HEATING VALUE (BTU/LB)	1902
HEAT LOSS DUE TO UNBURNED CARBON (%)	0.00
CARBON IN RESIDUE (%)	0.00
EXIT GAS TEMPERATURE (Deg. F)	1000
AMBIENT DRY BULB TEMP (Deg.F)	80
HUMIDITY RATIO (LBS H2O/LB DRY AIR)	0.0132
BAROMETRIC PRESSURE (IN.Hg.)	29.92
RADIATION LOSS (%)	0.00
UNACCOUNTABLE LOSS (%)	0.00
ENTHALPY ADDED IN BOILER (BTU/LB)	0

ADIABATIC FLAME TEMPERATURE &
COMBUSTION CALCULATIONS

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CLIENT	COE	DATE	14-Jun-90
PLANT	RAAP	TIME	12:31 PM

HEAT LOSSES	MMBTU/HR	PERCENT
IN DRY FLUE GAS	1.31	29.37
FROM H2O IN AIR	0.02	0.35
FROM H2O IN FUEL--SENSIBLE	0.50	11.21
FROM H2O IN FUEL--LATENT	2.63	59.06
TOTAL IN WET FLUE GAS	4.45	100.00
DUE TO UNBURNED CARBON	0.00	0.00
DUE TO HOT ASH	0.00	0.00
DUE TO RADIATION & UNACCOUNTABLE	0.00	0.00
TOTAL	4.45	100.00

BOILER EFFICIENCY (%)	0.00
STEAM GENERATED (LBS/HR)	ERR
UNBURNED CARBON (LBS/HR)	0
LBS OF WET FLUE GAS PER LB FUEL	3.41
SPEC.VOL.OF WET FLUE GAS (CU.FT./LB)	42.47
AIR TO FUEL RATIO (LB AIR/LB FUEL)	2.38
COMB. AIR SPECIFIC VOL. (CU.FT/LB)	13.712
COMBUSTION AIR FLOW (LBS/HR)	5635

F L U E G A S A N A L Y S I S

	% BY VOLUME		% BY WEIGHT	
	WET	DRY	WET	DRY
CO2	7.64	13.39	13.41	19.38
SO2	0.0232	0.0406	0.0592	0.0856
O2	1.65	2.89	2.11	3.04
HCL	0.0000	0.0000	0.0000	0.0000
N2	47.77	83.68	53.61	77.49
H2O	42.91		30.81	

FLUE GAS FLOWS

	WET	DRY
MASS (LBS/HR)	7972	5516
VOLUME (ACFM)	5643	3222
(SCFM)(70DEG.F.)	2049	1170
@ 12% CO2	1305	1305
"F" FACTOR (DSCF/MMBTU @12% CO2)		17605

ADIABATIC FLAME TEMPERATURE &
COMBUSTION CALCULATIONS

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CLIENT	COE	DATE	14-Jun-90
PLANT	RAAP	TIME	06:54 PM

FUEL ULTIMATE ANALYSIS

CONSTITUENT	WT.PCT.	DRY FUEL RECEIVED	DRY & ASH FREE	ADJUSTED FUEL
CARBON	12.48	86.40	86.40	86.40
HYDROGEN	1.83	12.70	12.70	12.70
OXYGEN	0.01	0.10	0.10	0.10
NITROGEN	0.01	0.10	0.10	0.10
SULFUR	0.10	0.70	0.70	0.70
CHLORINE	0.00	0.00	0.00	0.00
WATER	85.56	0.00	0.00	0.00
INERTS	0.00	0.00	0.00	0.00
TOTAL	100.00	100.00	100.00	100.00

FUEL RATE (TONS/DAY)	25
TOTAL AIR ASSIGNED (%)	115
FUEL HIGHER HEATING VALUE (BTU/LB)	1902
HEAT LOSS DUE TO UNBURNED CARBON (%)	0.00
CARBON IN RESIDUE (%)	0.00
EXIT GAS TEMPERATURE (Deg. F)	1000
AMBIENT DRY BULB TEMP (Deg.F)	80
HUMIDITY RATIO (LBS H2O/LB DRY AIR)	0.0132
BAROMETRIC PRESSURE (IN.Hg.)	29.92
RADIATION LOSS (%)	0.00
UNACCOUNTABLE LOSS (%)	0.00
ENTHALPY ADDED IN BOILER (BTU/LB)	0

ADIABATIC FLAME TEMPERATURE &
COMBUSTION CALCULATIONS

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CLIENT	COE	DATE	14-Jun-90
PLANT	RAAP	TIME	06:54 PM

HEAT LOSSES	MMBTU/HR	PERCENT
IN DRY FLUE GAS	1.18	29.37
FROM H2O IN AIR	0.01	0.35
FROM H2O IN FUEL--SENSIBLE	0.45	11.21
FROM H2O IN FUEL--LATENT	2.36	59.07
TOTAL IN WET FLUE GAS	4.00	100.00
DUE TO UNBURNED CARBON	0.00	0.00
DUE TO HOT ASH	0.00	0.00
DUE TO RADIATION & UNACCOUNTABLE	0.00	0.00
TOTAL	4.00	100.00

BOILER EFFICIENCY (%)	0.00
STEAM GENERATED (LBS/HR)	ERR
UNBURNED CARBON (LBS/HR)	0
LBS OF WET FLUE GAS PER LB FUEL	3.41
SPEC.VOL.OF WET FLUE GAS (CU.FT./LB)	42.47
AIR TO FUEL RATIO (LB AIR/LB FUEL)	2.38
COMB. AIR SPECIFIC VOL. (CU.FT/LB)	13.712
COMBUSTION AIR FLOW (LBS/HR)	5071

F L U E G A S A N A L Y S I S

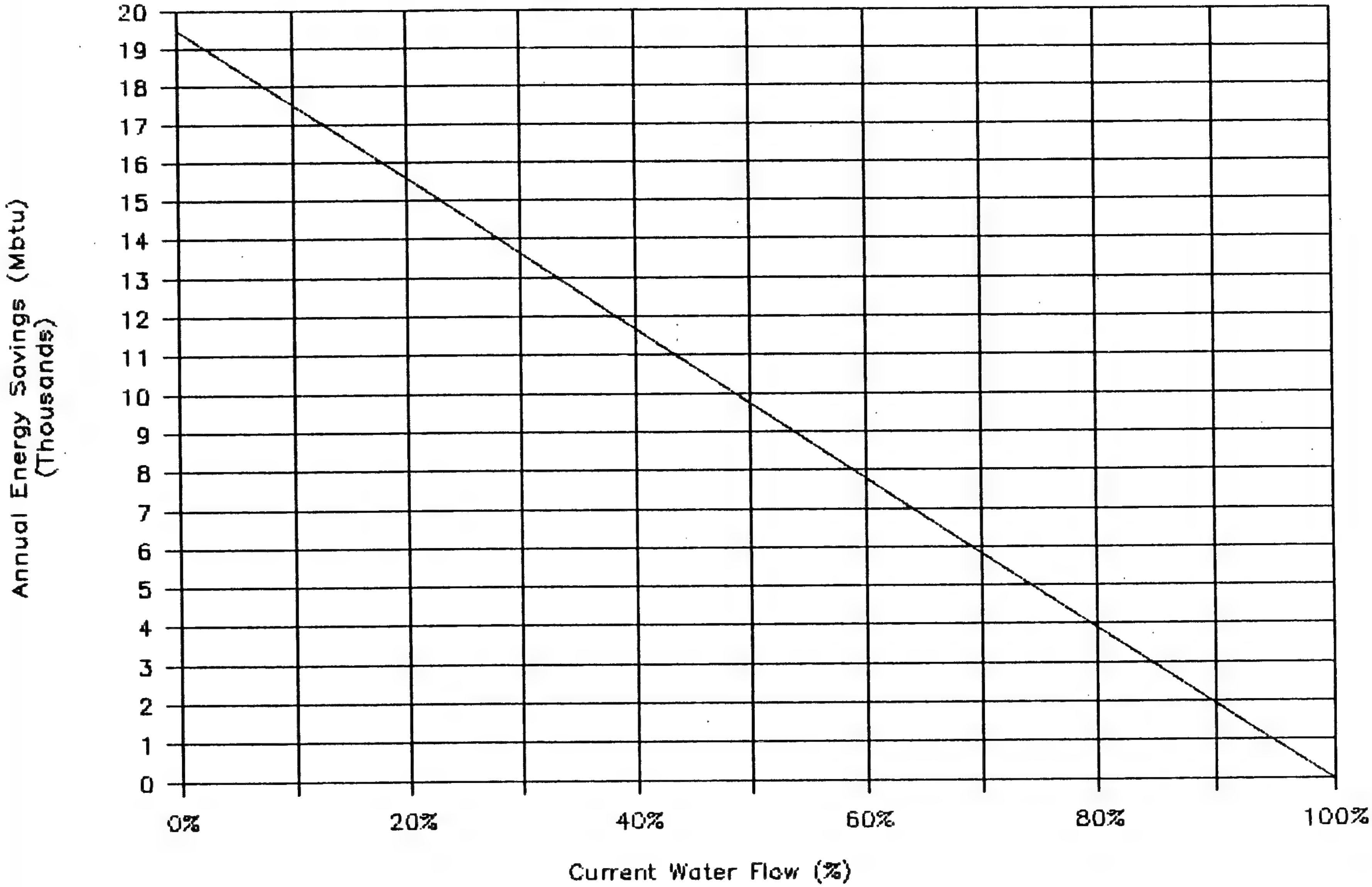
	% BY VOLUME		% BY WEIGHT	
	WET	DRY	WET	DRY
CO2	7.64	13.39	13.41	19.38
SO2	0.0232	0.0406	0.0592	0.0856
O2	1.65	2.89	2.11	3.04
HCL	0.0000	0.0000	0.0000	0.0000
N2	47.77	83.68	53.61	77.49
H2O	42.91		30.81	

FLUE GAS FLOWS

	WET	DRY
MASS (LBS/HR)	7175	4964
VOLUME (ACFM)	5079	2899
(SCFM)(70DEG.F.)	1844	1053
@ 12% CO2	1174	1174
"F" FACTOR (DSCF/MMBTU @12% CO2)		17605

Radford Army Ammunition Plant

Annual Energy Savings vs Percent Current Water Flow (3.9 gpm)



HUNTER **Telephone Call Confirmation**

Project No. 290-0379-000

Local ______ L.D. X Placed X Rec'd. ______ Date 5-22-90

______ Conversed With (404) 394-6200

Of ~~DOR~~ DORR OLIVER Regarding HYDROCLONES

1" HYDROCLONE is correct SIZE PROVIDED PARTICLES CAN PASS 4mm ORIFICE WILL GET 50/50 SPLIT DOWN TO 30 μ AT 50 PSIG ΔP. COST IS $100.00

Distribution:

CONSTRUCTION COST ESTIMATE	DATE PREPARED 5-23-90	SHEET 1 OF

PROJECT
ENERGY ENGINEERING ANALYSIS

LOCATION
RADFORD ARMY AMMUNITION PLANT

ARCHITECT ENGINEER
REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE
- [ ] CODE A (No design completed)
- [x] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.	ESTIMATOR	CHECKED BY
	G. FALLON	[illegible]

ADD HYDROCLONE TO INCIN. SLURRY LINE SUMMARY	QUANTITY NO. UNITS	UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
1 IN HYDROCLONE	1	EA	30	30	$100	100	130
1" 316SS pipe	300	ft	3.99	1197	7.42	2226	3423
Fiberglass insulation							
w/ service jacket							
1" wall, 1" pipe	300	ft	1.56	468	1.37	411	879
SUB TOTAL				1695		2737	4402
LOCATION			.683	1158	1.002	2742	3900
SALES TAX (4.5%)				0		123	123
SUB TOTAL				1158		2865	4023
FICA/INSURANCE (20%)							805
SUB TOT							4828
OH (15%)							724
SUB TOT							5552
PROFIT (10%)							555
SUB TOT							6107
BOND (1%)							61
SUB TOT							6168
CONTINGENCY (7.5%)							463
SUB TOT							6631
Hercules Support (6%)							398
TOTAL							7029
				Two hydroclones			×2
					TOTAL		$14,058

ENG FORM 150
1 AUG 59 (ER 1110-345-730) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)
* U.S. GOVERNMENT PRINTING OFFICE . 19[illegible] O—[illegible]

RS&H®

SUBJECT ______ AEP NO ______

SHEET ______ OF ______

DESIGNER G. FALLON DATE 6/14/90

CHECKER P. HUTCHINS DATE 6/14/90

ECO # GP-X-3 REDUCE INCINERATOR EXCESS AIR

COMBUSTION PROGRAM

THE BOILER / COMBUSTION PROGRAM WAS ADAPTED TO IGNORE HEAT ABSORBTIONS BY ZEROING BOILER RELATED INPUT PARAMETERS.

WITH THE MASS & ENERGY FLOWS BALANCED FOR A 1000°F EXIT GAS TEMPERATURE AND 115 % AIR FLOW, THE HEAT LOSSES IN THE STACK GASES ARE 4.45 MBTU/HR (PAGE 2). FOR 300% AIR FLOW (≈15% O_2 IN STACK) THE LOSSES ARE 6.57 MBTU/HR (PAGE 5).

ANNUAL ENERGY SAVINGS

(6.57 − 4.45) MBTU/HR × 8760 × .5 = 9286 MBTU/yr

FOR BOTH INCINERATORS

9286 × 2 = 18572 MBTU/yr.

COST SAVINGS

18572 MBTU/yr × $4.27 /MBTU = $79,300 /yr.

ADIABATIC FLAME TEMPERATURE &
COMBUSTION CALCULATIONS

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CLIENT	COE	DATE	14-Jun-90
PLANT	RAAP	TIME	01:08 PM

FUEL ULTIMATE ANALYSIS

CONSTITUENT	WT.PCT.	DRY FUEL RECEIVED	DRY & ASH FREE	ADJUSTED FUEL
CARBON	12.48	86.40	86.40	86.40
HYDROGEN	1.83	12.70	12.70	12.70
OXYGEN	0.01	0.10	0.10	0.10
NITROGEN	0.01	0.10	0.10	0.10
SULFUR	0.10	0.70	0.70	0.70
CHLORINE	0.00	0.00	0.00	0.00
WATER	85.56	0.00	0.00	0.00
INERTS	0.00	0.00	0.00	0.00
TOTAL	100.00	100.00	100.00	100.00

FUEL RATE (TONS/DAY)	28
TOTAL AIR ASSIGNED (%)	115
FUEL HIGHER HEATING VALUE (BTU/LB)	1902
HEAT LOSS DUE TO UNBURNED CARBON (%)	0.00
CARBON IN RESIDUE (%)	0.00
EXIT GAS TEMPERATURE (Deg. F)	1000
AMBIENT DRY BULB TEMP (Deg.F)	80
HUMIDITY RATIO (LBS H2O/LB DRY AIR)	0.0132
BAROMETRIC PRESSURE (IN.Hg.)	29.92
RADIATION LOSS (%)	0.00
UNACCOUNTABLE LOSS (%)	0.00
ENTHALPY ADDED IN BOILER (BTU/LB)	0

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ADIABATIC FLAME TEMPERATURE &
COMBUSTION CALCULATIONS

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CLIENT	COE	DATE	14-Jun-90
PLANT	RAAP	TIME	01:08 PM

HEAT LOSSES	MMBTU/HR	PERCENT
IN DRY FLUE GAS	1.31	29.37
FROM H2O IN AIR	0.02	0.35
FROM H2O IN FUEL--SENSIBLE	0.50	11.21
FROM H2O IN FUEL--LATENT	2.63	59.07
TOTAL IN WET FLUE GAS	4.45	100.00
DUE TO UNBURNED CARBON	0.00	0.00
DUE TO HOT ASH	0.00	0.00
DUE TO RADIATION & UNACCOUNTABLE	0.00	0.00
TOTAL	4.45	100.00

BOILER EFFICIENCY (%)	0.00
STEAM GENERATED (LBS/HR)	ERR
UNBURNED CARBON (LBS/HR)	0
LBS OF WET FLUE GAS PER LB FUEL	3.41
SPEC.VOL.OF WET FLUE GAS (CU.FT./LB)	42.47
AIR TO FUEL RATIO (LB AIR/LB FUEL)	2.38
COMB. AIR SPECIFIC VOL. (CU.FT/LB)	13.712
COMBUSTION AIR FLOW (LBS/HR)	5635

FLUE GAS ANALYSIS

	% BY VOLUME		% BY WEIGHT	
	WET	DRY	WET	DRY
CO2	7.64	13.39	13.41	19.38
SO2	0.0232	0.0406	0.0592	0.0856
O2	1.65	2.89	2.11	3.04
HCL	0.0000	0.0000	0.0000	0.0000
N2	47.77	83.68	53.61	77.49
H2O	42.91		30.81	

2

F L U E G A S F L O W S

	WET	DRY
MASS (LBS/HR)	7972	5516
VOLUME (ACFM)	5643	3222
(SCFM)(70DEG.F.)	2049	1169
@ 12% CO2	1305	1305
"F" FACTOR (DSCF/MMBTU @12% CO2)		17605

ADIABATIC FLAME TEMPERATURE &
COMBUSTION CALCULATIONS

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CLIENT	COE	DATE	14-Jun-90
PLANT	RAAP	TIME	01:19 PM

FUEL ULTIMATE ANALYSIS

CONSTITUENT	WT.PCT.	DRY FUEL RECEIVED	DRY & ASH FREE	ADJUSTED FUEL
CARBON	12.48	86.40	86.40	86.40
HYDROGEN	1.83	12.70	12.70	12.70
OXYGEN	0.01	0.10	0.10	0.10
NITROGEN	0.01	0.10	0.10	0.10
SULFUR	0.10	0.70	0.70	0.70
CHLORINE	0.00	0.00	0.00	0.00
WATER	85.56	0.00	0.00	0.00
INERTS	0.00	0.00	0.00	0.00
TOTAL	100.00	100.00	100.00	100.00

FUEL RATE (TONS/DAY)	28
TOTAL AIR ASSIGNED (%)	300
FUEL HIGHER HEATING VALUE (BTU/LB)	1902
HEAT LOSS DUE TO UNBURNED CARBON (%)	0.00
CARBON IN RESIDUE (%)	0.00
EXIT GAS TEMPERATURE (Deg. F)	1000
AMBIENT DRY BULB TEMP (Deg.F)	80
HUMIDITY RATIO (LBS H2O/LB DRY AIR)	0.0132
BAROMETRIC PRESSURE (IN.Hg.)	29.92
RADIATION LOSS (%)	0.00
UNACCOUNTABLE LOSS (%)	0.00
ENTHALPY ADDED IN BOILER (BTU/LB)	0

ADIABATIC FLAME TEMPERATURE &
COMBUSTION CALCULATIONS

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CLIENT	COE	DATE	14-Jun-90
PLANT	RAAP	TIME	01:19 PM

HEAT LOSSES	MMBTU/HR	PERCENT
IN DRY FLUE GAS	3.41	76.62
FROM H2O IN AIR	0.04	0.90
FROM H2O IN FUEL--SENSIBLE	0.50	11.21
FROM H2O IN FUEL--LATENT	2.63	59.07
TOTAL IN WET FLUE GAS	6.57	147.80
DUE TO UNBURNED CARBON	0.00	0.00
DUE TO HOT ASH	0.00	0.00
DUE TO RADIATION & UNACCOUNTABLE	0.00	0.00
TOTAL	6.57	147.80

BOILER EFFICIENCY (%)	-47.80
STEAM GENERATED (LBS/HR)	ERR
UNBURNED CARBON (LBS/HR)	0
LBS OF WET FLUE GAS PER LB FUEL	7.29
SPEC.VOL.OF WET FLUE GAS (CU.FT./LB)	39.60
AIR TO FUEL RATIO (LB AIR/LB FUEL)	6.21
COMB. AIR SPECIFIC VOL. (CU.FT/LB)	13.712
COMBUSTION AIR FLOW (LBS/HR)	14699

F L U E G A S A N A L Y S I S

	% BY VOLUME		% BY WEIGHT	
	WET	DRY	WET	DRY
CO2	3.84	4.95	6.27	7.39
SO2	0.0116	0.0150	0.0277	0.0327
O2	11.05	$\boxed{14.27}$	13.14	15.48
HCL	0.0000	0.0000	0.0000	0.0000
N2	62.54	80.76	65.44	77.09
H2O	22.57		15.11	

5

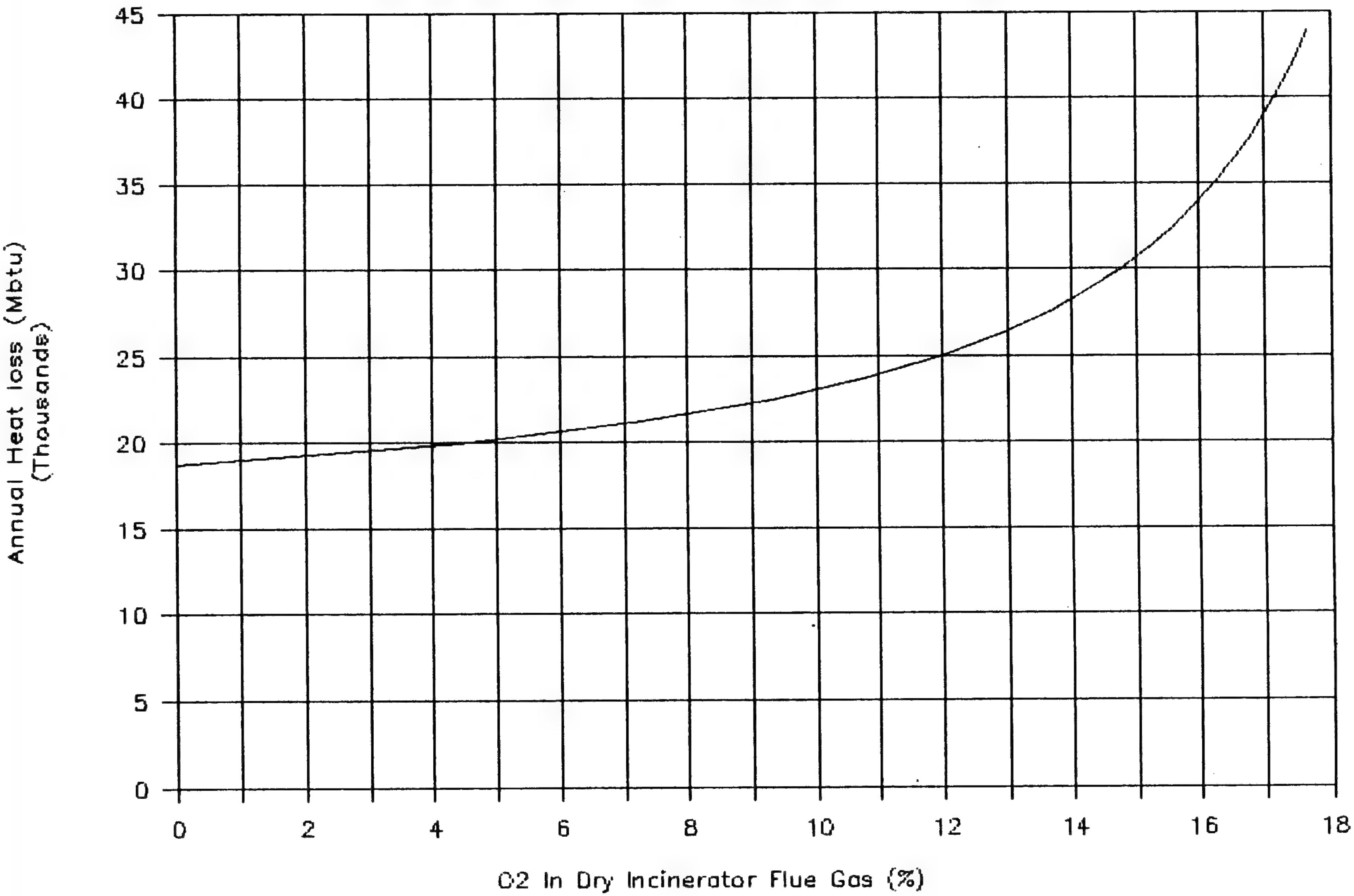
F L U E G A S F L O W S

	WET	DRY
MASS (LBS/HR)	17036	14462
VOLUME (ACFM)	11245	8707
(SCFM)(70DEG.F.)	4082	3161
@ 12% CO2	1305	1305
'F' FACTOR (DSCF/MMBTU @12% CO2)		17605

2

Radford Army Ammunition Plant

Annual Heat Loss vs O2 In Incinerator Flue @ 1000 F



ECO# GP-X-4 INSTALL TURNING VANES IN BOILER DUCTS

PRESSURE DROP WITH EXISTING SQUARE CORNER

ASSUME: 5280 FT/min, 300°F EXIT GAS TEMP.,

ASPECT RATIO (W/D) = 1

FROM FIG 20 (ATTACHED) PRESSURE DROP IS 0.8 IN.W.C

PRESSURE DROP WITH 24" RADIUS BEND IN LIEU OF

SQUARE CORNER. ASSUME 6'X6' DUCT.

$$R/D = \frac{24/12}{6} = .333$$

FROM FIG 20 ΔP = 0.28 IN. W.C.

FAN ENERGY SAVED

VOLUME = 6'x6' x 5280 FT/MIN = 190,000 ACFM

$$\text{ENERGY} = \frac{(190,000)(0.8 - 0.28)}{6356 \times .7} \times 746 = 16.56 \text{ kW}$$

ASSUME 50% LOAD FACTOR ON FAN

16.56 kw x 8760 hr/yr x .5 = 72532 kwh/yr.

72532 Kwh/yr x 3413 $\frac{BTU}{Kwh}$ x 10^{-6} $\frac{MBTU}{BTU}$ = 248 MBTU/yr

Typically 3 boilers operate in winter and 2 in the summer

Assuming 2.5 boilers and 4 elbows per boiler

gives 2.5 * 4 * 248 MBtu/yr = 2480 MBTU/yr

RS&H®

SUBJECT ______________________ AEP NO ______________________

______________________ SHEET ________ OF ________

DESIGNER PFH DATE ______________________

CHECKER ______________________ DATE ______________________

<u>QRIP Calc'n</u>

Current energy use =

$$\frac{(100{,}000)\ (0.3)}{6356 \times 0.7} \times \frac{746}{1000} \times \frac{3760}{2} \times 0.03026 = \$\ [illegible]/\text{elbow}$$

$$\$\,3378 \times 10 \text{ elbows} = \underline{\$\,33{,}780/\text{yr}}$$

FRICTION LOSS IN RECTANGULAR DUCTS

All of the losses are figured for unlined steel ducts at 70 F and A/B ratio = 1. Correct for other temperatures and ratios as shown.

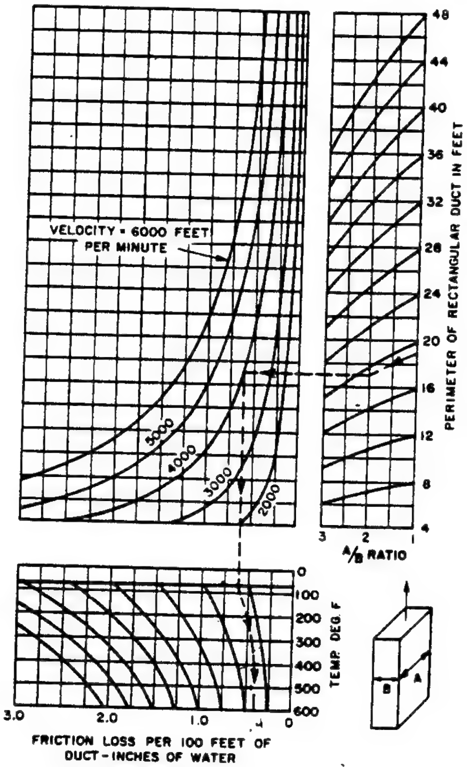


Fig. 19

FRICTION LOSS IN PLAIN RECTANGULAR ELBOWS

All of the losses are figured for unlined steel elbows at 70 F and W/D ratio = 1. Correct for other temperatures and ratios as shown.

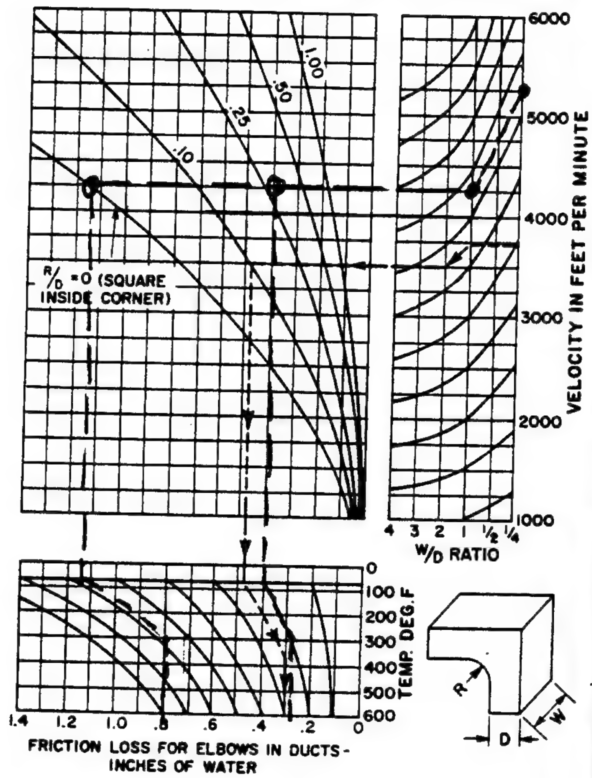


Fig. 20

24" RADIUS BEND MAT'L COST

ASSUME: 7 gage PLATE, 6 ft WIDE DUCT, $2/LB STEEL

AREA

$$24 \text{ IN} \times \frac{1 \text{ ft}}{12 \text{ IN}} \times \frac{2\pi}{4} \times 6 \text{ ft} = 18.85 \text{ ft}^2/\text{bend}$$

weight

7 gage PLATE weighs 7.5 LBS/ft^2

$$18.85 \text{ ft}^2/\text{bend} \times 7.5 \text{ LBS}/\text{ft}^2 = 141 \text{ LBS}/\text{bend}$$

Cost

STEEL PLATE COSTS ABOUT $2/LB* FABRICATED

* MEANS SPECIALTY STEEL

141 LBS/bend x $2/LB = $282/bend.

CONSTRUCTION COST ESTIMATE

DATE PREPARED

SHEET OF

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: RADFORD ARMY AMMUNITION PLANT

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE

- [ ] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.

ESTIMATOR: G. Fallon

CHECKED BY: P. Hutchins

ROUNDED DUCT CORNER. SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
BEND COST MAT'L	1	ea			282	282	282
LABOR Q9	3	days	346.32	1039			1039
REMOVE EXISTING							
CORNER CREW Q9	.5	days	346.32	173		282	455
TOTAL				1212		282	1494
LOCATION			.683	828	1.002	282	1110
SALES TAX			1.00	828	1.045	295	1123
FICA			1.20	994	1.00	295	1289
OVERHEAD 15%							1482
PROFIT 10%							1631
BOND 1%							1647
CONTINGENCY 10%							1812
HERCULES 6%							1920
TOTAL PER ELBOW							1920
Five boilers & 4 elbows each							X20
TOTAL CONSTRUCTION COST							$33,400

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT RAAP EEAP
T-Stat Control System
DESIGNER W. T. Todd
CHECKER P. Hutchins

AEP NO 2100377000
SHEET 1 OF
DATE 5/11/90
DATE 6/12/90

ECO # GP-X-5

INSTALL THERMOSTAT CONTROL IN MOTOR HOUSES

Assumptions:

1. Based on the Department of the Army Technical Manual a freeze is possible for Roanoke, VA from October to May. This analysis assumes the radiators in the motor houses are left on for this period.

2. The main plant boiler efficiency is 76.6% and 15% distribution losses.

3. The average motor house dimensions are 7.5' by 7.5' by 7.5'.

4. The 99% winter design temperature is 9°F for Radford Ordnance Works (DA Technical Manual).

5. The design temperature for the motor house is assumed to be 60°F.

Current Energy Consumption:

Heat loss $= Q = U \cdot A \cdot \Delta T$

$U = 1/R_t$

$U = 1/1.69$

$U = 0.59 \frac{Btu}{Hr \cdot Ft^2 \cdot {}^\circ F}$

Outside air film (15 mph)	$R = 0.17 \frac{Hr \cdot Sq\,Ft \cdot {}^\circ F}{Btu}$
Asbestos shingles (1/4", lapped)	$R = 0.21$
Wood siding (1/2", pine)	$R = 0.63$
Inside air film (still)	$R = 0.68$
Total	$R_t = 1.69$ Hr·Ft²·°F/Btu

A = Surface Area = (7.5 ft × 7.5 ft)/exposure × 5 exposures = 281 Ft²

ΔT = Inside Temp − Outside Temp = 60°F − 9°F = 51°F

GP-X-5

Calculations (continued):

Since the radiators currently have no thermostat, the radiator output is assumed constant for all outside air temperatures.

$Q = U \cdot A \cdot \Delta T$, existing energy consumption

$$Q = 0.59 \frac{Btu}{hr \cdot ft^2 \cdot °F} * 281\ ft^2 * 51\ °F = 8455\ Btu/hr$$

With thermostatic control, the motor house can be maintained at 40 °F to prevent freezing. The on/off control valve will reduce the radiator operating times.

$$\text{Current operating time} = 8\ mo \times 30 \frac{day}{mo} \times \frac{24\ hr}{day} = 5760\ hrs$$

New operating time = 1833 hours {Dept. of Army Tech. Manual}
(hours temp. is at or below 40 °F)

$$\text{Steam savings} = 8455 \frac{Btu}{hr} * (5760 - 1833)\ hrs/yr * 105\ \text{buildings}$$

$$\text{Steam Savings} = 33.2\ MBtu/yr \times 105 = 3486\ MBtu/yr$$

$$\text{Coal Savings} = 3486 \frac{MBtu}{yr} \times 1.32 = \underline{4602\ MBtu/yr}$$

$$\text{Energy Cost Savings} = 4602 \frac{MBtu}{yr} \times 1.61 \frac{\$}{MBtu} = \underline{\$\ 7409/yr}$$

$$\text{Elec. Price Diff Cost} = 3486 * \$1.11 = \underline{\$3869/yr}$$

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT T-stat Control System
DESIGNER W. T. Todd
CHECKER JA
AEP NO
SHEET 3 OF
DATE
DATE

GP-X-5

Calculations (continued):

Net cost savings = \$7409 - 3869 = \$3540/yr

Construction Cost:

Project Cost = \$40,273 see construction cost estimate sheet for details.

Simple Payback

Payback = Cost ÷ Annual Savings

= \$40,273 ÷ 3540 \$/yr

= 11.4 years

CONSTRUCTION COST ESTIMATE	DATE PREPARED Sept. 19, 1990	SHEET 4 OF

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: RADFORD ARMY AMMUNITION PLANT

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE:
- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.: N A | ESTIMATOR: W. T. Todd | CHECKED BY: [illegible]

T-Stat Control SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
Steam Valve - 2 Position	1	Ea	15	15.00	125	125.00	140.00
Thermostat - J.C. #T-26	1	Ea	25	25.00	50	50.00	75.00
Power Connection	1	Ea	25	25.00	20	20.00	45.00
Subtotal				65.00		195.00	260.00
Location Adjustments			0.683	(20.61)	1.002	0.39	(20.22)
Sales Tax					4.5%	8.79	8.79
FICA / Insurance			20%	8.88			8.88
Subtotal							257.45
Overhead	15%						38.62
Profit	10%						29.61
Performance Bond	1%						3.26
RAAP Support	6%						19.74
Contingency	10%						34.86
Construction Cost (each building)							$ 383.55
Construction Cost (for 105 buildings)							$40,272.75

Vendor Quote for Material Costs - Johnson Controls

Labor Costs from Means Mechanical Cost Data

ENG FORM 150, 1 AUG 59 (ER 1110-345-730) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

* U.S. GOVERNMENT PRINTING OFFICE . 1959 O—510140

RS&H

Telephone Call Confirmation

Project No. 290-0379-000

Local 733-1411 L.D. ______ Placed ______ Rec'd. ______ Date 9-19-90

Bill Todd Conversed With Sam Pruitt

Of Johnson Controls Regarding T-stat Control - Radford AAP

Radiators can be controlled with a thermostat and a steam valve. The thermostat is a J.C. model #T-26 and costs about $50. Johnson Controls does not make a 2-position steam valve anymore but many other companys do - the cost ranges from $100 to $150.

Distribution:

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT .... AEP NO ....
SHEET ...... OF ......
DESIGNER W Todd DATE ....
CHECKER DATE ....

MOTOR HOUSES UNDER 100 Ft^2

Name	Area	Sq. Ft.	Number	Page #'s
Motor House	NC-A	48	2	9
Motor House	A-Green	47	1	10
Elevator Mtr. Hse.	Sol. Rec.	56	63	11-16
Elevator Mtr Hse.	A-Finish	56	5	16-17
Motor House	NC-B	48	1	19
Motor House	B-Green	47	1	20
Motor House	NC-C	48	2	21
Motor House	C-Green	47	1	22
Elevator Mtr. Hse.	C-Finish	56	3	24
Elevator Mtr. Hse.	C-Green	56	2	24
Motor House	Premix-1	96	2	30
Motor House	Double Base	78	1	30
Elev. Mtr. Hse.	Double Base	56	1	30
Elevator Mtr. Hse.	Sol. Rec.	56	12	30-31
Motor House	A-Finish	55	4	34-35
Motor House	Premix 1	54, 78, 53	3	36
Motor House	RP-4	99	1	45
	TOTAL		105	

RS&H®

SUBJECT

AEP NO

SHEET / OF

DESIGNER G. FALLON DATE 6/14/90

CHECKER P. HUTCHING DATE 6/14/90

ECO # GP-X-6 CHANGE INCINERATOR FUEL TO NAT. GAS

INCINERATOR FUEL COST SAVINGS

FUEL OIL SAVINGS = 86,217 MBTU/yr

NAT GAS INCREASE = 86,217 MBTU/yr

Current energy costs:

86,217 * 4.27 = $368,148/yr.

New energy costs:

86,217 * 3.36 = $289,689/yr.

Savings = $78,458/yr.

CONSTRUCTION COST ESTIMATE	DATE PREPARED	SHEET OF

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: RADFORD ARMY AMMUNITION PLANT

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE

- [ ] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.: ECO # GP-X-6

ESTIMATOR: G FALLON

CHECKED BY: PFH

INCIN. NAT. GAS LINE SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
Hercules Estimate							166,000
SUB TOTAL COST							166,000
OVERHEAD 15%							191,000
PROFIT 10%							210,000
BOND 1%							212,000
CONTINGENCY 5%							222,000
SIOH 6%							236,000
DESIGN FEES 6%							250,000
TOTAL							250,000

ENG FORM 1 AUG 59 150 (ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

HUNTER **Telephone Call Confirmation**

Project No. 290 - 0379 -000

Local ______ L.D. X Placed X Rec'd. ______ Date 5-31-90

G. F. Conversed With Pat ZEEK

Of Radford (US. Govm'T) Regarding Gas line for incinerators

Incinerator Gas line - Past study citation.

Date of Study - ~~87~~ '86

Scope of work - ie: Incinerator Burners new? NO!

Total installed cost - $142,960 +

Any Energy Savings? - NO.

HOW MUCH - 0

"Put or Pay" contract with Gas company is under negotiation and proceeding slowly.

Original $87-130,000/yr. savings

200-250K ~~total~~ installed cost.

Because of fuel oil and natural gas price fluctuations Radford projects a 25-30% cost saving to switch to natural gas.

Distribution:

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT RAAP EEAP
Shut off Preheat Coils
DESIGNER W. T. Todd
CHECKER PA

AEP NO. 290-0379-000
SHEET 1 OF
DATE 6-8-90
DATE

ECO # MF-X-1

AUTOMATIC SHUT-OFF OF PRE-HEAT COIL AT F.A.D.'s

Assumptions:

1. The outside air opening is 3'x 3' and the flow rate is 11,000 ft^3/min for each side of the FAD buildings.

2. The steam pre-heat coil is made from iron pipe that an inside diameter of 1 inch and an outside diameter of 1¼ inches, and is 30 feet in length.

3. 40 lb. steam is supplied to the pre-heat coils from October through May. They are currently controlled manually.

4. There are 4005 hours during October - May when the temperature is greater than or equal to 40 °F. Department of the Army Technical Manual, Engineering Weather Data, pages 3-398 & 3-399.

5. Temperature in the FAD's is controlled about 50 % of the time.

6. Assume the coils will only operate when the outside air temperature is below 40 °F, and the average temperature during these months is 49 °F, Statistical Abstract of the U.S., 1987.

Calculations:

Evaluate properties at $T_m = (T_{pipe} + T_\infty)/2$

from steam tables @ 40 psig: $T_{pipe} = 287°F$

$T_m = (287°F + 49°F)/2 = 168°F$

Calculations (Continued):

When FAD is not operating - heat transfer from preheat coil occurs due to natural convection (h_{nc}) and radiation (h_r).

$$h_t = h_{nc} + h_r$$

$$h_{nc} = (N_{nu} * k)/L_c$$

$L_c = D = 0.104$ ft

$N_{nu} = C\,(N_{gr} N_{pr})^n$

$N_{gr} = L_c^3 * \rho^2 * \beta * \Delta T * g / u^2$

$N_{pr} = C_p * u / k = 0.72$

$u = 1.390$ EE -5 lb/ft·sec

$\rho = 0.064$ lb/ft^3

$\beta = 1.61$ EE -3 1/°F

$\frac{g\beta\rho^2}{u^2} = 1.14$ EE 6 1/ft^3·°F

PE Review Manual Appendix 3.4

$$N_{gr} = (0.104\,ft)^3 * 238°F * 1.14\,EE6\,\frac{1}{ft^3 \cdot °F} = 3.05\,EE\,5$$

$$N_{gr} N_{pr} = 3.05\,EE5 * 0.72 = 2.20\,EE\,5$$

$C = 0.53$, $n = 0.25$

Table 3.7, pg 3-17 PE Review Manual

Calculations (continued):

$$N_{nu} = \frac{h_{nc} L_c}{k} = C\left(N_{gr} N_{pr}\right)^n = 0.53(2.20\ EE\ 5)^{0.25} = 11.37$$

$$h_{nc} = 11.37 * k / L_c = \frac{11.37 * 0.0168 \frac{Btu}{hr \cdot ft \cdot {}^\circ F}}{0.104\ ft} = 1.84 \frac{Btu}{hr \cdot ft^2 \cdot {}^\circ F}$$

$$h_r = \frac{F_e F_a \sigma \left(T_p^4 - T_w^4\right)}{T_p - T_a}$$

T_p = Temperature of pipe ≈ 287 °F = 747 °R

T_w = Temperature of wall ≈ 49 °F = 509 °R

T_a = Ambiant air temp. ≈ 49 °F = 509 °R

σ = S-B constant = 0.1713 EE −8 $Btu/hr \cdot ft^2 \cdot {}^\circ R^4$

ϵ_p = emissivity of pipe ≈ 0.64 oxidized cast iron at 168°F
Appendix 3.5, pg 3-30

$F_e = \epsilon_p$ (For enclosed body, $A_w >> A_p$) = 0.64 Table 3.11

F_a = Shape Factor = 1 (For surrounded radiator) Page 3-24

$$h_r = \frac{0.64 * 1 * 0.1713\ EE{-8} \frac{Btu}{hr \cdot ft^2 \cdot {}^\circ R^4}\left[(747\,{}^\circ R)^4 - (509\,{}^\circ R)^4\right]}{(287-49)\,{}^\circ F}$$

$$h_r = \frac{267.8\ Btu/hr \cdot ft^2}{238\ {}^\circ F} = 1.13\ Btu/hr \cdot ft^2 \cdot {}^\circ F$$

$$h_t = h_{nc} + h_r = 1.84 + 1.13 = 2.97\ Btu/hr \cdot ft^2 \cdot {}^\circ F$$

REYNOLDS, SMITH AND HILLS
ARCHITECTS • ENGINEERS • PLANNERS
INCORPORATED

SUBJECT Shut off Preheat Coils
DESIGNER W.T. Todd
CHECKER
AEP NO
SHEET 4 OF
DATE
DATE

MF-X-1

Calculations (continued):

$\Delta T = 287°F - 49°F = 238°F$

$A = \pi D L = \pi * 0.104 ft * 30 ft = 9.8 ft^2$

$Q = h_t A \Delta T$ = energy use while FAD is not operating

$Q = 2.97\ Btu/hr \cdot ft^2 °F \times 9.8\ ft^2 \times 238°F \times 4005\ \frac{hr}{yr} \times 0.5 = 13.9\ MBtu/yr$

Steam Savings:

Steam Savings = Q × # Systems/Bldg × # Bldgs.

$= 13.9\ \frac{MBtu}{yr} \times \frac{2\ systems}{Bldg} \times 21\ Bldg = 583.8\ \frac{MBtu}{yr}$

Coal Savings:

Savings = $583.8\ \frac{MBtu}{yr} * 1.21 = 706\ MBtu/yr$

\$ Savings = 706 MBtu/yr × 1.61 \$/MBtu = \$1137/yr

Elec Price Diff Costs

= 583.8 MBtu/yr * \$0.35/MBtu = \$204/yr

Net Cost Savings

\$ Savings = \$706 - 204 = \$502/yr

MF-X-1

Calculations (Continued):

Project Cost:

Construction Cost = $60,871 See Cost Estimate Sht.

Simple Payback:

Payback = Cost ÷ Savings

= $60,871 ÷ $502/yr = 121.2 years

CONSTRUCTION COST ESTIMATE | DATE PREPARED 6-11-90 | SHEET 6 OF

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: RADFORD ARMY AMMUNITION PLANT

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE

- [X] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.: NA | ESTIMATOR: W. T. Todd | CHECKED BY:

S/O Preheat Coils SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
O.A. Temperature Sensor	1	Ea	25	25.00	90	90.00	115.00
Modulating Setpoint							
Compination Valve, 1"	1	EA	100	100.00	590	590.00	690.00
Misc. Mechanical			25	25.00	25	25.00	50.00
Misc. Electrical			25	25.00	25	25.00	50.00
Subtotal				175.00		730.00	905.00
Sales Tax				—	4.5%	32.85	32.85
FICA/Insurance			20%	35.00		—	35.00
Subtotal				210.00		762.85	972.85
Overhead	15%						145.93
Profit	10%						111.88
Performance Bond	1%						12.31
Hercules Support	6%						74.58
Contingency	10%						131.76
Subtotal							1449.31
x 2 systems per building x 21 buildings							x 42
Construction Cost							$60,871

Modified vendor quote of equipment cost only by Johnson Controls, Jacksonville, FL 904/733-1411

HUNTER

Telephone Call Confirmation

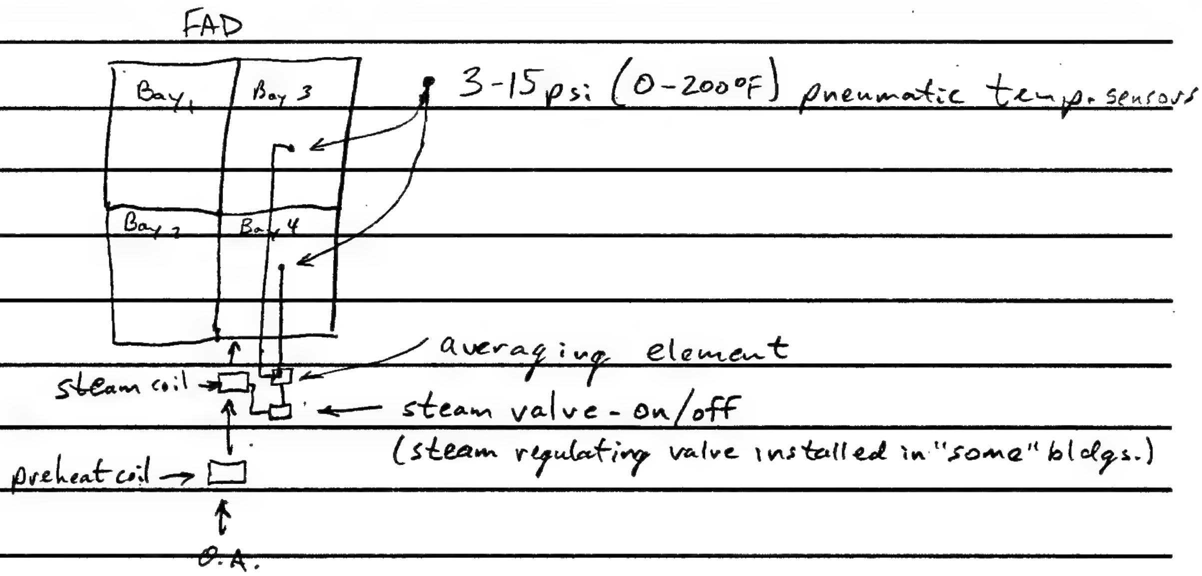
Project No. 290 0379 000

703/639-8549

Local ______ L.D. ______ Placed ______ Rec'd. ______ Date 6-8-90

B. Todd Conversed With Rodney Epperly

Of RAAP Maintenance Regarding FAD Heating Systems



Mr. Childers has the most knowledge of the FAD buildings - this is the second week of his 3 week vacation.

9-19-90 Called Steve Debusk / Junior Childers

Active FAD's operate approximately 70 to 80 hours per week. The fans are operating and the temp. is maintained during these hours.

Distribution:

HUNTER **Telephone Call Confirmation**

Project No. 290-0379-000

Local 733-1411 L.D. ________ Placed ________ Rec'd. ________ Date 6-11-90

B. Todd Conversed With Sam Pruitt

Of Johnson Controls Regarding RAAP - Preheat Coil Control

Pre-heat pipes can be controlled either with pneumatic or electric controls. Requires a 2-way modulating valve and a 2-position Outside air thermostat.

Sam will prepare a preliminary design sketch and estimate, and FAX them to me today.

Distribution:

JOHNSON CONTROLS
8245 Bayberry Road
Jacksonville, FL 32256

FAX # (904) 733-3335

TO: RSH.

DATE: 6-11-90

TIME:

ATTN: Bill TODD

TELECOPY #: 731-1673

CONFIRMATION #

NUMBER OF PAGES (INCLUDING COVER) 3

MESSAGE REMARKS:

Mr. TODD

The attached are sketches and prices for Material only for 2 ways to control Preheats - Note this method puts the Discharge Temp after O.A Drops under control with an ADjustable setpoint.

TELECOPY SENT BY: [signature]

SHOULD YOU HAVE ANY PROBLEMS RECEIVING THIS MESSAGE, PLEASE CONTACT AT (904) 733-1411.

BSH- Bill TODD

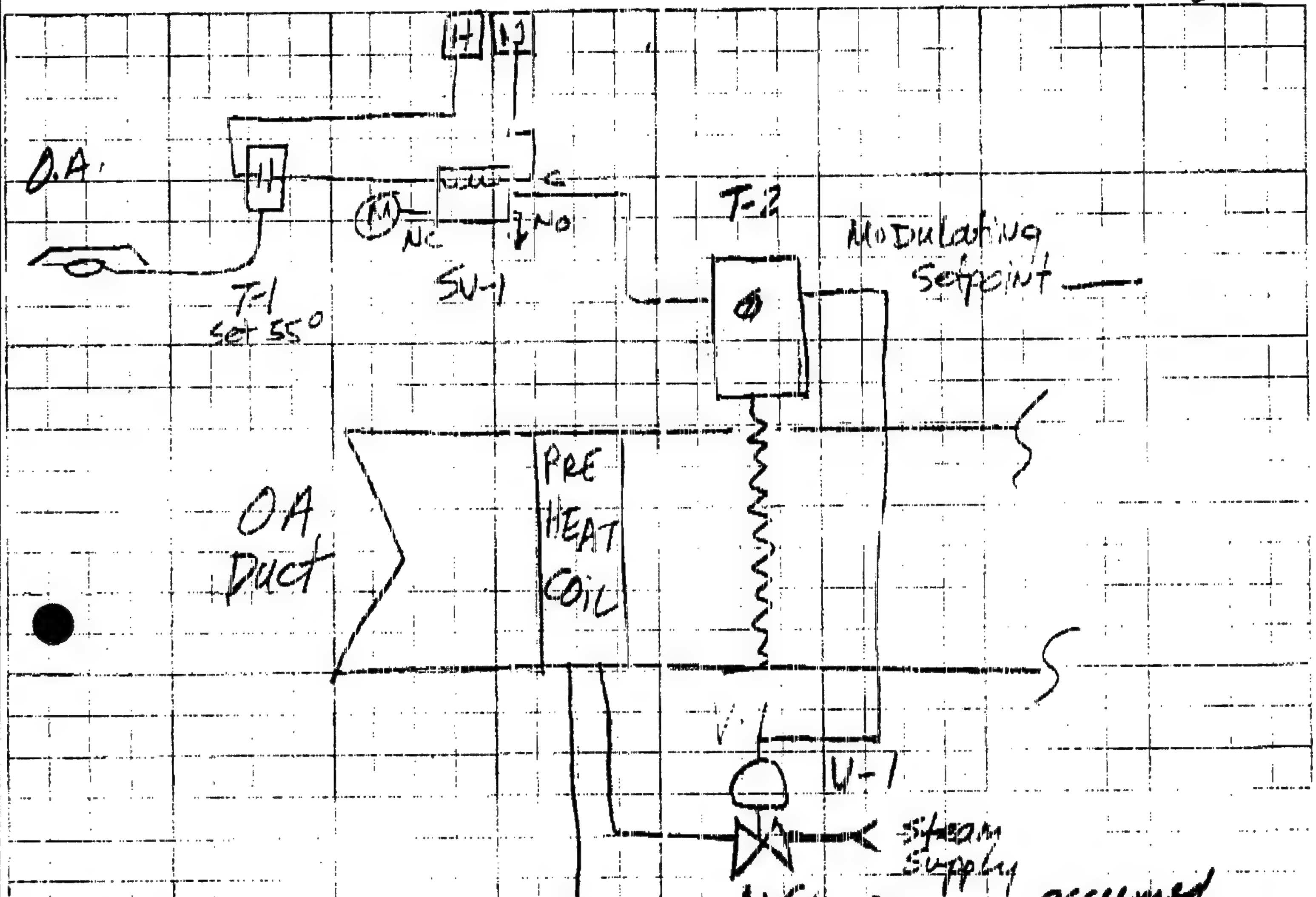
WORKSHEET

JOHNSON CONTROLS

Subject: 120VAC

Date: Sam Pruett

PAGE 1 of 2



Condensate

assumed 3/4" valve

Assumes

1. 20 PSI Air Available
2. Installation not included
3. Steam valve ∠ 3/4"

T-1	$90.00
SV-1	$115.00
T-2	$350.00
V-1	$200.00
	755.00
Misc	50.00
=	800.00

Pneumatic Option

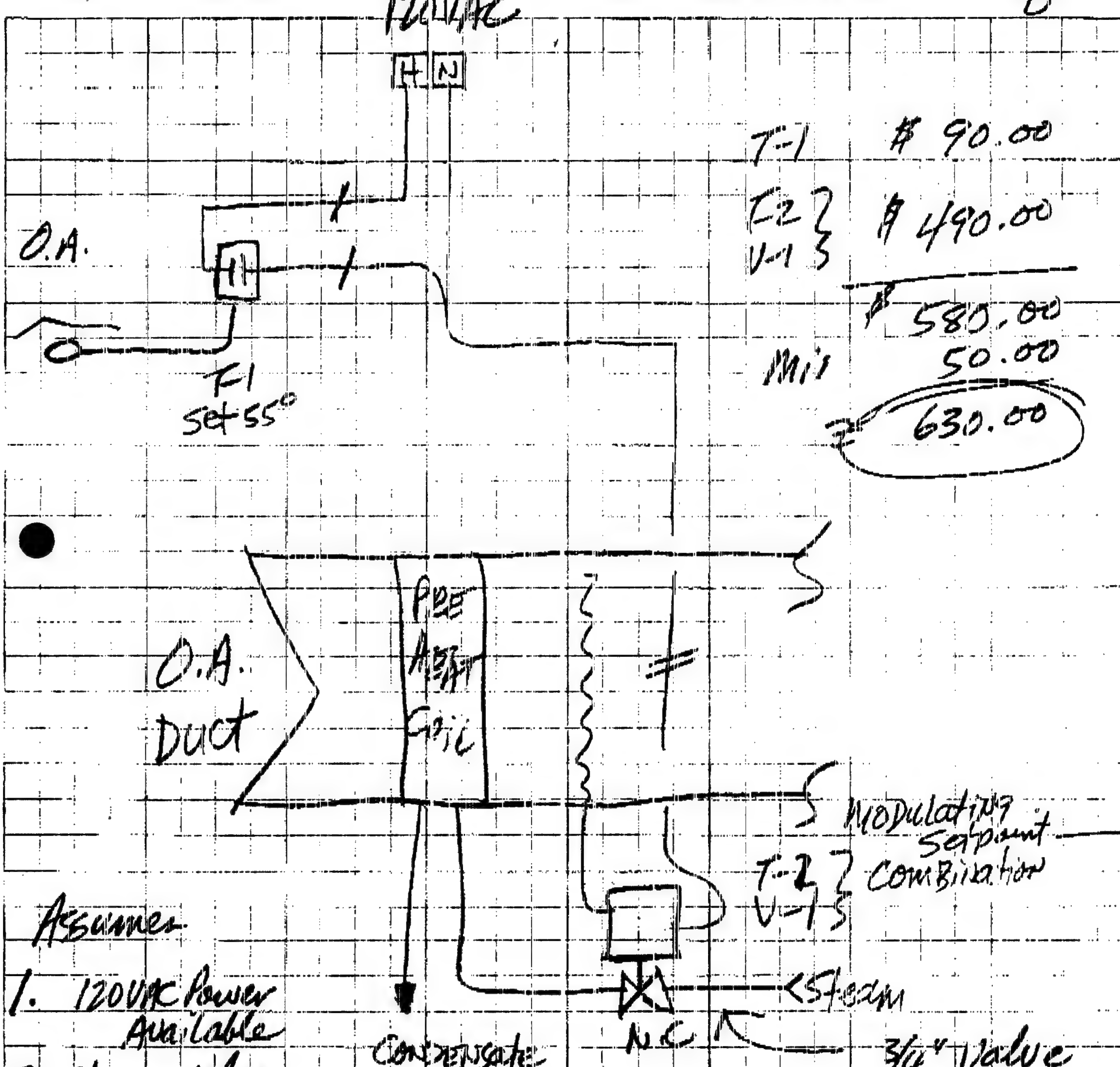
RSA

Bill TODD

WORKSHEET

JOHNSON CONTROLS

Subject:	Date:	PAGE 2 of 2



T-1 $ 90.00
T-2, V-1 $ 490.00
$ 580.00
Mis 50.00
630.00

Assumes
1. 120VAC Power Available
2. Steam Valve ∠ 3/4"

Electric Option

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SUBJECT Insulate Boiling Tubs AEP NO. 290 0379 000
SHEET 1 OF
DESIGNER PFH DATE
CHECKER DATE

ECO # NC-U-1

1. Calculate tub heat loss

Assumptions:
Tub dimensions 18' dia 12' hi
Steel thickness 0.25"
$T_{out} = 62F$
$T_{in} = 212F$

Calculate tub surface area

top	$= \pi D^2/4$	=	254 sf
bottom	= "	=	254 sf
sides	$= \pi D H$	=	679 sf

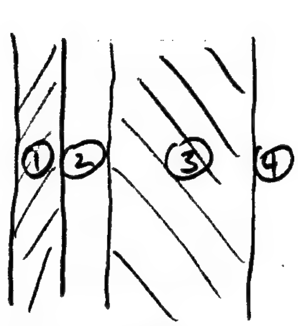
Calculate heat transfer coefficients

SIDES

w/o insulation

	R
① steel (0.25") =	–
② outside airfilm =	1.35
Σ =	1.35

$U = 1/\Sigma R = 0.741$



w/ insulation

	R
① steel =	—
② air space (1") =	1.25
③ fiberglass (2") =	8.00
④ airfilm =	0.68
	9.93

$U = 1/\Sigma R = 0.10$

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AEP NO.
SHEET 2 OF
DATE
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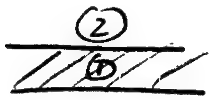
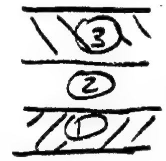
w/o insulation — w/ insulation

TOP



	R
(1) steel	–
(2) outside film	1.1
	1.1

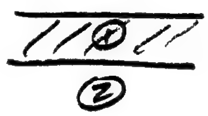
$U = 1/\Sigma R = 0.91$



(1) steel	–
(2) space	1.83
(3) insul.	8.00
(4) film	0.61
	10.44

$U = \frac{1}{\Sigma R} = 0.096$

BOTTOM



	R
(1) steel	–
(2) outside film	2.70
	2.70

$U = 1/\Sigma R = 0.37$

2. Calculate total heat loss without insulation

$Q = UA\Delta T = (0.74)(679)(150) + (0.91)(254)(150) + (0.37)(254)(150) = 124{,}137$ Btu/hr

3. Calculate heat loss with insulation on top and sides

$Q = UA\Delta T \quad (0.10)(679)(150) + (0.096)(254)(150) + (0.37)(254)(150) = 27{,}940$ Btu/hr

4. Energy savings are the difference = 96,197 Btu/hr per tub

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DATE
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NC-U-1

5. Calculate coal savings per tub

$$(96{,}197 \text{ Btu/hr}) \times 1.32 \frac{\text{Btu coal}}{\text{Btu steam}} = 126{,}980 \text{ Btu/hr}$$

6. Calculate annual savings per tub

Assume tub operates 75% of the time

126,980 Btu/hr * 8760 * 0.75 = 834.3 MBtu per tub

7. Calculate total annual savings
Insulate five boiling tubs and three poachers

834.3 * 8 = 6674 MBtu
6674 × 1.61 \$/MBtu = \$10,745/yr

8. Calculate Electricity Price Differential Costs

(96,197 Btu/hr/tub) * 8760 HRS * 0.75 * 8 tubs = 5056 MBtu/yr.

5056 * \$1.11 = \$5612/yr.

Cost Estimate

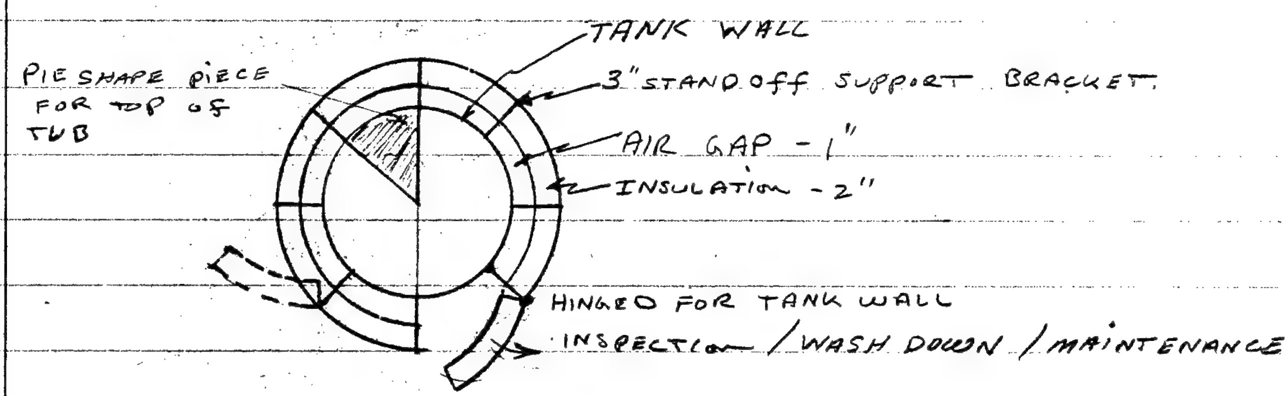
INSULATION COSTS (1989 Means Mech. p 171)

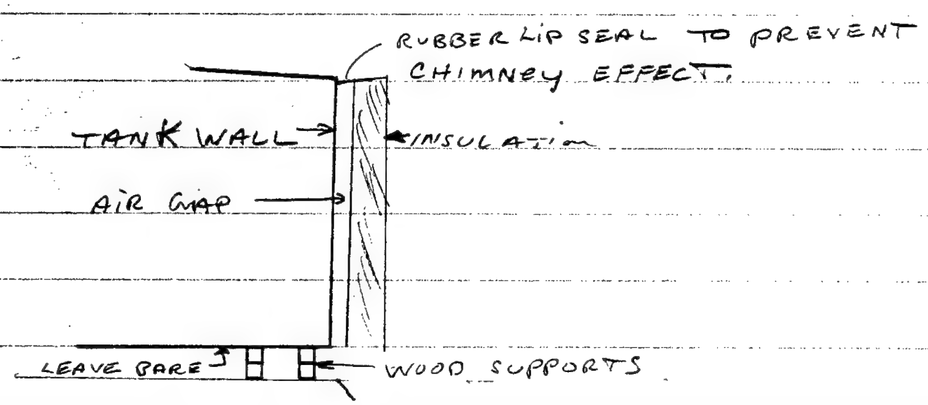
$0.42/ft^2 mat — # 0.42

1.11/ft^2 labor * 0.68 adj = 0.75

$ 1.57/ft^2 total — # 1.17 * 933 sf = # 1092

NOTE: FOR SAFETY REASONS INSULATION MAY NOT BE APPLIED DIRECTLY TO THE TANK WALL. A 1 INCH STAND OFF SUPPORT FRAME SHOULD BE USED





RE-PIPING COSTS

ASSUME: SCH 40, 316 SS, WELDED, 4" φ, 24' EQUIV.,

\$45/LF (MEANS pg. 75)

#36/LF	mat			#36	mat
9/LF	lab	* 0.68 (adj.) =		6	lab
#45/LF	total			#42	tot

INSULATION SUPPORT BRACKET

ASSUME: 96 ft 3"x3" STAINLESS @ #3.75 LF

ASSUME: 1 WEEK INSTALLATION, @ #35.00/MHR, 2 MEN.

35 x 2 x 40	=	#2800	labor
96 x 3.75	=	360	materials
TOTAL		3160	

TOTAL INSTALLED COST

		lab	mat
INSULATION	\$ 1092	700	392
Re Piping	1008	144	864
SUPPORT BRACKET	3160	2800	360
	\$ 5260	3644	1616

CONSTRUCTION COST ESTIMATE	DATE PREPARED 6/8/90	SHEET OF

PROJECT ENERGY ENGINEERING ANALYSIS	BASIS FOR ESTIMATE
LOCATION RADFORD ARMY AMMUNITION PLANT	☐ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify)
ARCHITECT ENGINEER REYNOLDS, SMITH AND HILLS A.E.P., INC.	

DRAWING NO.	ESTIMATOR	CHECKED BY
ECO # NC-U-1	PFH	GF

Boiling Tub Ins. SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
Re-piping				144		864	1008
Insulation				700		392	1092
Brackets				2800		360	3160
subtotals				3644		1616	5260
sales tax (4.5%)						73	73
FICA / Ins (20.0%)				729			729
Subtotals				4373		1689	6062
Overhead (15%)							909
Profit (10%)							697
Bond (1%)							77
Contingency (7.5%)							581
							$ 8326
5 Boiling Tubs							
3 Poachers							x8
							$66,608

ENG FORM 150 1 AUG 59 (ER 1110-345-730) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

RS&H®

SUBJECT ______ AEP NO ______

SHEET 1 OF ______

DESIGNER [illegible] DATE 9-24-90

CHECKER [illegible] DATE ______

ECO # NC-X-1 INSTALL BOILING TUB HEAT EXCHANGER

Hercules data shows boiling tubs consume 1403 LBS/HR of 40 psig STEAM for a tub on boil.

HEAT CONSUMPTION

$$\frac{1408 \text{ LBS/HR/TUB} \times 1175 \text{ BTU/LB}}{10^6 \text{ BTU/MBTU}} = 1.654 \text{ MBTU/HR/TUB}$$

OTHER DATA SHOWS A TUB IS ON BOIL FOR ABOUT 75% OF ITS CYCLE

ANNUAL HEAT CONSUMED

1.654 MBTU/HR/TUB X 8760 X .75 = 10,870 MBTU/year/tub

PERCENT HEAT SAVED BY CONDENSING STEAM

$$\% = \frac{h_{fg}}{h_f} \times 100$$

$$= \frac{919 \text{ BTU/LB}}{1175 \text{ BTU/LB}} \times 100 = 78.2\%$$

ANNUAL HEAT SAVED @ TUBS

10,870 MBTU/year/TUB x .782 = 8501 MBTU/yr/TUB

ANNUAL COAL SAVINGS

Coal savings = 8501 x 1.32 = 11,221 MBtu/tub

3/91

RS&H®

SUBJECT

DESIGNER GF

CHECKER DA

AEP NO

SHEET 2 OF

DATE

DATE

NC-X-1

Electricity price differential costs:

\$1.11/MBTU 40#STM. x 8501 MBTU = \$9436 /yr /TUB

3/91

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SUBJECT ______ AEP NO ______

SHEET 3 OF ______

DESIGNER SJ DATE 9/25/90

CHECKER BA DATE ______

NC-X-1

Calculate # of tubs ~~to~~ used each year

27.9×10^6 # NC/yr ÷ 30,000 LBS NC/TUB cycle = 930 TUB cycles/yr

$$\frac{930 \text{ TUB cy/yr} \times 100 \text{ HR/cy}}{8760 \text{ HR/yr}} = 10.6 \text{ TUBS} \approx 11 \text{ TUBS.}$$

assuming 85% AVAILABILITY

$$\frac{11 \text{ tubs}}{.85} = 12.9 \approx 13 \text{ TUBS.}$$

RAAP COAL ENERGY SAVINGS

11,221 MBTU/yr/TUB × 11 TUBS = 123,431 MBTU COAL/yr

123,431 * \$1.61 = \$198,724/yr.

Electricity Price Differential Costs:

8501 MBtu/Tub * \$1.11/MBtu * 11 tubs = \$103,797

RAAP NET SAVINGS

\$198,724 − 103,797 = \$94,927/yr

RS&H

SUBJECT ______

DESIGNER GF

CHECKER RH

AEP NO ______

SHEET 4 OF ______

DATE ______

DATE ______

NC-X-1

~~TOTAL~~ INSTALLED COST

COST = #44613 FOR 5 TUBS

$\frac{\#44613}{5 \text{ TUBS}} \times 13 \text{ TUBS} = \#115{,}993$

SIMPLE PAYBACK

$\frac{\#115{,}993}{94{,}927} = \underline{1.2 \text{ yrs}}$

For QRIP:

TOTAL COAL USED PER TUB

$10{,}370 \text{ mBtu/yr/tub} \times 1.32 \frac{\text{mBtu coal}}{\text{mBtu stm}} = \underline{14{,}348} \text{ mBtu}$

FUEL COST = 14,348 mBtu × \$1.61/mBtu = #23,100

SAVINGS = COAL SAVINGS − ELEC PRICE DIFF COSTS

= (11,221 mBtu × #1.61) − #9436 = #8630

TDIFF (PROPOSED METHOD) = #14,470

COST = #115,993 / 5 = = #3924

3/91

CONSTRUCTION COST ESTIMATE | DATE PREPARED | SHEET OF

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: RADFORD ARMY AMMUNITION PLANT

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE
- ☐ CODE A (No design completed)
- ☐ CODE B (Preliminary design)
- ☐ CODE C (Final design)
- ☐ OTHER (Specify)

DRAWING NO.: ECO # ~~GE~~ NC-X-1

ESTIMATOR: GFallon

CHECKED BY: [signature]

PERC. LINE H/X SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
HEAT EXCHANGER							
3" SS 150 LB FLANGE	4	ea	29.00	116	129.15	517	633
SS 150 LB 4X3 REDUCE	2	ea	30.00	60	100.00	200	260
3" SCH 80 316 PIPE	20	FT	8.60	172	57.28	1145	1317
4" SCH 40 316 PIPE	20	FT	9.05	181	35.36	707	888
PUMP							
MECH	1	ea	88	88	1560	1560	1648
ELEC (means pg 277)	1	ea	430	430	290	290	720
INSULATION							
4" PIPE - 2" THK	20	FT	2.99	60	5.57	111	171
SUB TOTAL (ONE TUB)				1107		4530	5637
5 TUBS	5		1107	5535	4530	22650	28185
LOCATION FACTOR			.683	3780	1.002	22695	26475
SALES TAX			1	3780	1.045	23716	27496
FICA INS			1.2	4536	1.00	23716	28252
OVER HEAD 15%							32490
PROFIT 10%							35739
BOND 1%							36096
CONTINGENCY 10%							39706
Hercules 6%							42088
DESIGN FEE 6%							44613
TOTAL							44613
13 TUBS	13/5						$115,994
SOURCE: 1989 MEANS							

ENG FORM 150, 1 AUG 59 (ER 1110-345-730) PREVIOUS EDITION MAY BE USED. (TRANSLUCENT) * U.S. GOVERNMENT PRINTING OFFICE

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INCORPORATED

SUBJECT RAAP EEAP
Remove Steam Coils
DESIGNER W.T. Todd
CHECKER [initials]

AEP NO. 2900379000
SHEET 1 OF
DATE 5/21/90
DATE 6/12/90

ECO# SR-I-1

REMOVE STEAM COIL FROM A.C.S.R. DUCTWORK

Assumptions:

1. The 450 hp exhaust fan motors are oversized by 20%.

2. The total pressure on the fan is 20 inches of water.

3. The efficiency of the fan and drive assembly is 65%.

4. The efficiency of the fan motor is 85%.

5. There are three steam coils with 1 row and 14 fins per inch. The pressure drop across each coil is 0.75 inches of water.

6. The exhaust system operates 24 hours per day, 260 days per year (6240 hrs/yr).

Current Energy Consumption:

$$\text{Bhp} = \text{Motor hp} \div 1.2 = 450\text{ hp} \div 1.2 = 375\text{ Bhp}$$

$$\text{Power} = \frac{\text{Bhp} \times 0.746\,\frac{\text{kw}}{\text{hp}}}{\text{Motor Eff.}} = \frac{375 \times 0.746}{0.85} = 329\text{ Kw}$$

$$\text{Annual energy use} = 329\text{ kw} \times 6240\,\frac{\text{hrs}}{\text{yr}} = \underline{2{,}052{,}960\text{ Kwh/yr}}$$

$$\text{Annual energy use} = 2{,}052.96\,\frac{\text{Mwh}}{\text{yr}} \times 3.413\,\frac{\text{MBtu}}{\text{Mwh}} = \underline{7007\text{ MBtu/yr}}$$

$$\text{Annual energy cost} = 2{,}052{,}960\,\frac{\text{kwh}}{\text{yr}} \times 0.03026\,\$/\text{kwh} = \underline{\$62{,}123/\text{yr}}$$

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SUBJECT: Remove Steam Coils
DESIGNER: W. T. Todd
CHECKER:
AEP NO.
SHEET 3 OF
DATE
DATE

ECO Costs:

Cost for removing steam coils, replacing ductwork and adjusting fan drive = $16,997

Refer to Construction Cost Estimate sheet for detailed itemization of costs.

Simple Payback:

ECO Payback = Cost ÷ Savings

Payback = $16,997 ÷ $13,973/yr = 1.2 years

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SUBJECT: Remove Steam Coils
DESIGNER: W.T. Todd
CHECKER: BA

AEP NO.
SHEET 2 OF
DATE
DATE

Additional Energy Consumption:

There is no additional energy consumption required by this ECO.

Energy Savings:

$$\text{Exhaust CFM} = \frac{\text{Bhp} \times \text{Fan.Eff.} \times 6350}{\text{Total Pressure}}$$

$$\text{CFM} = \frac{375\text{ hp} \times 0.65 \times 6350}{20 \text{ in } H_2O} = 77{,}390 \ \frac{\text{cu.ft.}}{\text{min}}$$

The reduction in total pressure by removing the steam coils would be:

$$TP_r = 0.75 \text{ in.} H_2O/\text{coil} \times 3 \text{ coils} = 2.25 \text{ in.} H_2O$$

The reduction in fan horsepower required is:

$$HP_r = \frac{\text{CFM} * TP_r}{\text{Fan.Eff.} \times 6350} = \frac{77390 \times 2.25}{0.65 \times 6350} = 42 \text{ hp}$$

$$\text{Power} = \frac{\text{hp} \times 0.746}{\text{Motor Eff.}} = \frac{42 \times 0.746}{0.85} = 37 \text{ Kw}$$

$$\text{Energy Savings} = 2 \text{ bldgs} \times 37 \frac{\text{kw}}{\text{bldg.}} \times 6240 \text{ hr/yr} = \underline{461{,}760 \text{ Kwh/yr}}$$

$$\text{Energy Savings} = 461.76 \ \frac{\text{Mwh}}{\text{yr}} \times \frac{3.413 \text{ MBtu}}{\text{Mwh}} = \underline{1576 \text{ MBtu/yr}}$$

$$\text{Annual cost savings} = 461{,}760 \frac{\text{Kwh}}{\text{yr}} \times 0.03026 \text{ \$/kwh} = \underline{\$13{,}973/\text{yr}}$$

CONSTRUCTION COST ESTIMATE	DATE PREPARED 5/21/90	SHEET 4 OF

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: RADFORD ARMY AMMUNITION PLANT

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE:
- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.: NA | ESTIMATOR: W. T. Todd | CHECKED BY:

Remove Steam Coils SUMMARY	QUANTITY NO. UNITS	UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
Duct Demolition, 72"	30	LF	2.70	81.00	—	—	81.00
Coil Removal, 500 lb ea	1.5	Ton	395	592.50	—	—	592.50
Duct, 72" Stainless Steel	30	LF	31	930.00	63	1890.00	2820.00
Duct insulation; 1½", 1½ lb	565	SF	1.07	604.55	0.52	293.80	898.35
Duct ins. Jacket, Gal. Steel	30	LF	22.95	688.50	28.52	855.60	1544.10
Adjust fan, balance air	1	EA	150	150.00	25	25.00	175.00
Subtotal				3046.05		3064.40	6110.45
Location Adjustments			0.683	(965.60)	1.002	6.13	(959.47)
Sales Tax					4.5%	137.62	137.62
FICA / Insurance			20%	416.09			416.09
Subtotal							5704.69
Overhead	15%						855.70
Profit	10%						656.04
Performance Bond	1%						72.16
Contingency	10%						728.86
RAAP Support	6%						481.05
Construction Cost (for each building)							8498.50
Construction Cost (For two buildings)							$16,997.00
Source:							
Means Mechanical Cost Data, 1989, Bare Costs							

HUNTER

Telephone Call Confirmation

Project No. 2900379 000

Local ______ L.D. ______ Placed ______ Rec'd. ______ Date 5/17/90

Bill Todd Conversed With Everett Grubb / H. Hill

Of RAAP Maintenance Regarding Activated Carbon Sol. Recovery

Mr. Grubb was not available so I spoke with an assistant about heat recovery potential.

* Solvent condenser uses filtered water (not chilled water) at 40 lbs pressure.

* Steam coils are not used. The steam valves to these coils have been shut off.

Distribution:

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SUBJECT Remove Steam Coils
AEP NO
SHEET OF
DESIGNER W. T. Todd
DATE
CHECKER
DATE

Cost Estimate Back Up

Means Mech page

12 Coil removal 500 lb each $395 / ton

12 Duct removal 72" wide $2.70 / LF

231 New Duct - S. Steel 72" round

$$mat = \left(\frac{35 - 31.5}{4}\right) \times 32 + 35 = \$63.00 / LF$$

$$Lab = \left(\frac{15.4 - 13.45}{4}\right) \times 32 + 15.40 = \$31.00 / LF$$

171 Duct insulation

$$2\pi r l = 2 \times 3.14 \times 3 ft \times 30 ft = 565 sq.ft.$$

229 insulation jacket 74" ⌀

gal. steel

$$mat = \left(\frac{13.95 - 11.65}{6}\right) \times 38 + 13.95 = \$28.52 / LF$$

$$Lab = \left(\frac{13.45 - 11.95}{6}\right) \times 38 \times 13.45 = \$22.95 / LF$$

256 Fan adjustment (air balance) $175 each

COST ESTIMATE BACKUP

Means Mech.
page

12 Coil removal 500 lb each $395 / ton

12 Duct removal 72" wide $2.70 / LF

231 New Duct - S. steel 72" round

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$$\text{Lab} = \left(\frac{15.4 - 13.45}{4}\right) \times 32 + 15.40 = \$31.00 / \text{LF}$$

171 Duct insulation

$$2\pi r l = 2 \times 3.14 \times 3\text{ft} \times 30\text{ft} = 565 \text{ sq.ft.}$$

229 insulation jacket 74" ø

gal. steel

$$\text{mat} = \left(\frac{13.95 - 11.65}{6}\right) \times 38 + 13.95 = \$28.52 / \text{LF}$$

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256 Fan adjustment (air balance) $175 each

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SUBJECT ______ AEP NO ______

SHEET ______ OF ______

DESIGNER FFH DATE 11/2/90

CHECKER ______ DATE ______

Low/Cost, No/Cost Calculations

LCNC 1

1. Repair steam leaks (assume all are valves)

Cost

labor	materials
11 leaks	$ 1000
4 hours	11
44 total hrs.	$ 11,000
17.83 $/hr	
$ 785	

Source 59/90 Means

TOTAL COST = $ 11,785

Savings

@ 1/8" hole 40 psia steam losses 500 MBtu/yr

[illegible] savings are

1.32 MBtu coal for 1 MBtu steam
(App. [illegible] - Steam-to-Coal conversion factors)

500 × 1.32 × 11 = 7260 MBtu/yr

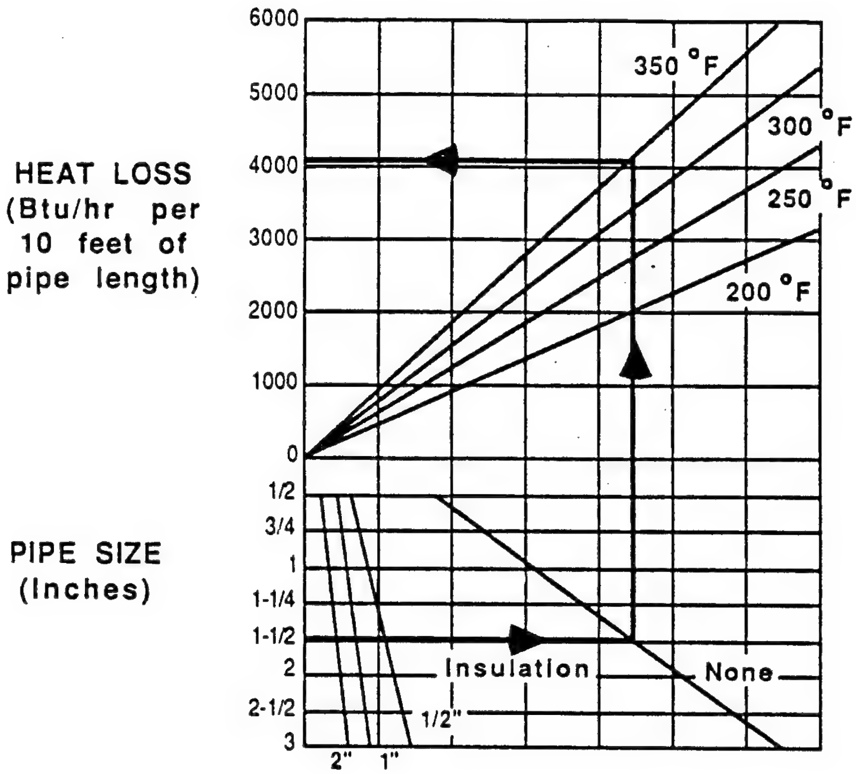
7620 × $1.61/MBTU = $ 11,689 /yr

Elec. Price Diff costs

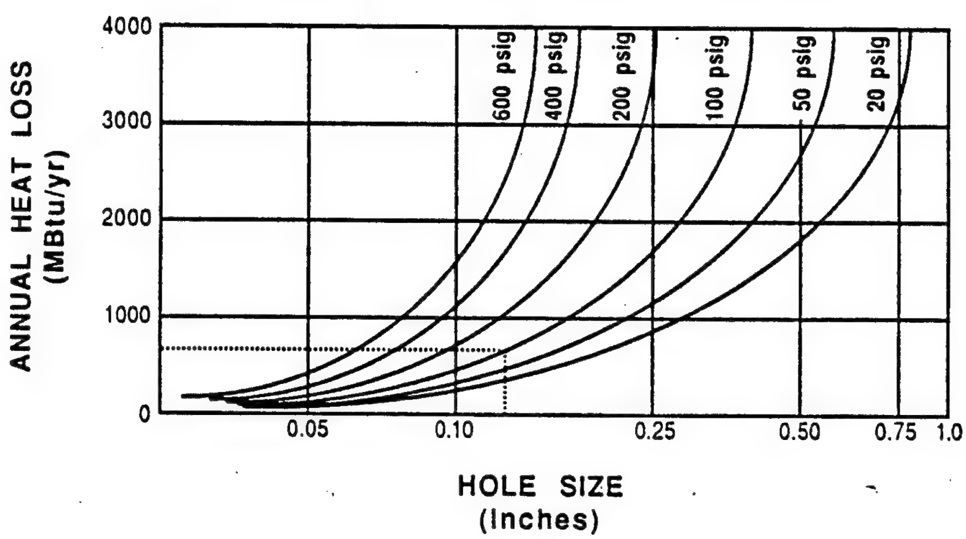
500 * 11 * $1.11 = $ 6105 / yr.

Net savings = $11,689 - 6105 = $ 5584 / yr

PIPING HEAT LOSSES



CALCULATED HEAT LOSS DUE TO STEAM LEAKS



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SUBJECT ______ AEP NO ______

______ SHEET ______ OF ______

DESIGNER ______ DATE ______

CHECKER ______ DATE ______

LCNC - 2 Turn off Unneeded Lights

Energy Savings

20 instances x 10 lights (avg) x 60 watts

x 10 hrs/da * 365 da/yr = 43,800 kwh/yr

Cost savings = 43,800 * $0.03026

= $1325/yr.

RS&H®

SUBJECT		AEP NO	
		SHEET	OF
DESIGNER	JH	DATE	11/13/90
CHECKER		DATE	

<u>LCNC 3</u> Repair Steam Pipe Insulation

2" Calcium silicate with aluminum jacket

Costs/lf — Labor — Materials — Source 39/90 Means

Labor hrs	Labor $	Materials
0.25	4.46	$ 4.75

Eight instances @ 10' per

Totals

Manhours	0.25 * 10 * 18	=	45
labor $	45 * 17.82	=	$ 802
Material	4.75 * 10 * 18	=	$ 855

total cost = $ 1657

Energy Savings

Heat loss (per diagram)

no insulation, 8" pipe, 350°F, 10' = 4000 Btu/hr

2" insulation 300

3700 Btu/hr

Elec. Price Diff. Costs = 3700 * 8760 * 8 * 1.11 ÷ 10^6 = $288

Fuel savings = 3700 × 1.32 × 8760 × 8 = 342 MBtu/yr

Energy Cost savings = 342 * 1.61 = $551/yr

Net Savings = 551 − 288 = $263/yr

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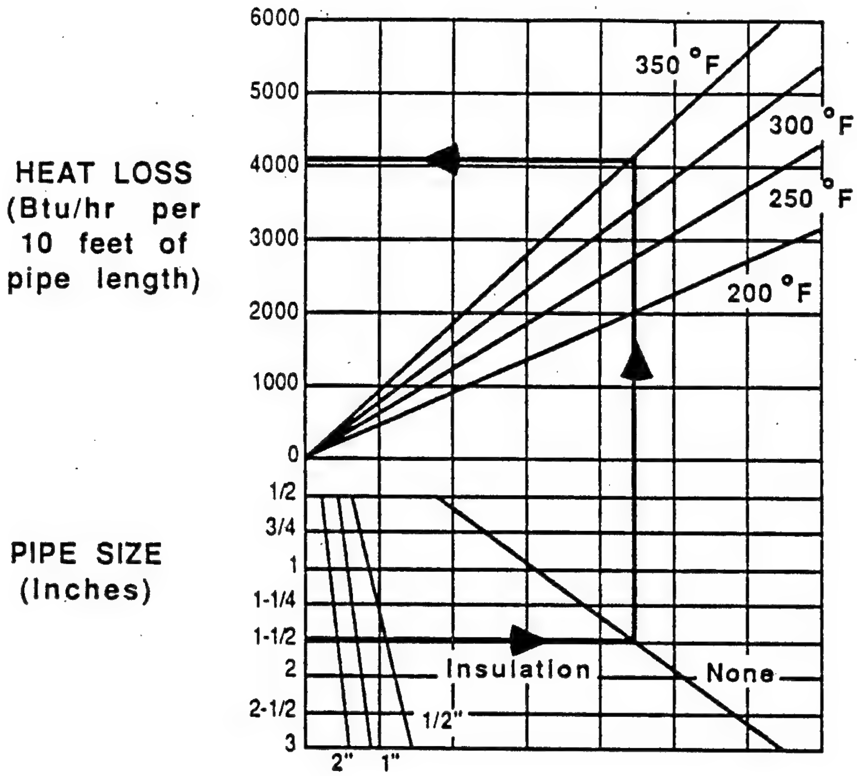
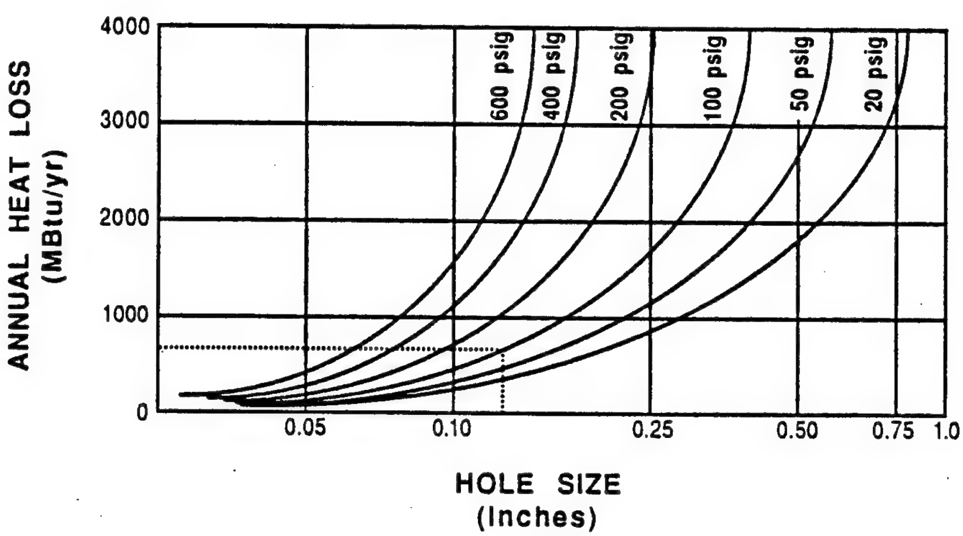
PIPING HEAT LOSSES



CALCULATED HEAT LOSS DUE TO STEAM LEAKS



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DESIGNER [initials] DATE ______

CHECKER ______ DATE ______

LCNC 4 Turn off steam when not needed.

A radiator uses about 2000 Btu/hr
(3 ft², 4 column)

If used during the non-heating season
this uses

$2000 \frac{Btu}{hr} * 5\ months * 30 \frac{da}{mon} * 24 \frac{hr}{da} * 1.32 \frac{stm}{coal} = 9.5\ MBtu/yr$ (coal) per rad.

3 instances, equivalent to 7 radiators each $= 7.2 \frac{MBtu\ stm}{yr/rad}$

Coal Savings = 9.5 * 21 = 200 MBtu/yr (coal)
Coal Cost Savings = 200 * 1.61 = \$322/yr.
Elec. Price Diff Costs = 7.2 * 21 * \$1.11 = \$168/yr
Net Savings = \$322 − \$168 = \$154/yr

Add for turning off carpet roll tables and roller cabinets on weekends

Loss per table − 30 x 6 = 180 sf
157°F

From ASHRAE 200 Btu/hr/sf = 34.6 MBtu/yr (stm)

Energy Savings = 180 * 200 * 5 mon/yr * 8 da/mon * 24 hr/da * 1.32 = 45.6 MBtu/yr (coal)

Energy Cost Savings = 46 x 1.61 = \$74/yr / table * 4 tables = \$296/yr ; 184 MBtu/yr

Elec Price Diff Cost = 34.6 * 1.11 * 4 = \$154/yr Net Savings = \$142/yr

Totals = 384 MBtu/yr ; \$296/yr.

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DATE ______

LCNC 5 Repair compressed air leaks

Savings

From ASHRAE, a 1/3" hole wastes #932/yr at 4¢/kwh

at 3.026¢/kwh => #742 /yr

742 / 3.026¢ = 24,550 kwh

84 MBtu/yr

Costs

Labor	Materials
2 hrs	#50
$17.83/hr	
35.66	50

Means 89/90 Means

TOTAL COST = #86

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TYPICAL COSTS FOR STUCK OPEN STEAM TRAPS (1)

STEAM PRESSURE = 100 PSIG (342 F)				STEAM PRESSURE = 200 PSIG		
TRAP SIZE (INCHES) =>	1/8	3/16	1/4	1/8	3/16	1/4
STEAM ENERGY LOSS (MBTU/YR) ===>	500	1100	2100	1250	2200	4000
STEAM COST ($/MBTU)						
$3.00	$1,000	$2,200	$4,200	$2,500	$4,400	$8,000
$3.58 (Note 2)	$1,789	$3,936	$7,514	$4,473	$7,872	$14,313
$5.00	$2,500	$5,500	$10,500	$6,250	$11,000	$20,000

(1) BASED ON A STEAM ENERGY VALUE OF 1000 BTU/LB AND STEAM LEAKAGE RATES AS GIVEN IN THE BARRON'S MANUAL OF ENERGY SAVINGS IN EXISTING PLANTS.

(2) CALCULATED USING A NATURAL GAS COST OF $2.29/MBTU AND ASSUMING A COMBUSTION EFFICIENCY OF 80% AND 20% DISTRIBUTION SYSTEM LOSSES.

ANNUAL COST FOR TYPICAL COMPRESSED AIR LEAKS

SYSTEM PRESSURE	HOLE DIAMETER	CUBIC FEET OF COMPRESSED AIR WASTED PER YEAR	COST OF ENERGY WASTED $/YEAR (1)
100 PSIG	3/8-inch	79,000,000	$8,734
	1/8-inch	8,880,000	$982
	1/32-inch	553,000	$61
70 PSIG	3/8-inch	59,100,000	$5,300
	1/8-inch	6,560,000	$588
	1/32-inch	410,000	$37

(1) BASED ON AN AVERAGE LOCAL ELECTRICITY COST OF 4.0¢/kWh INCLUDING DEMAND CHARGES.

Telephone Call Confirmation

reynolds, smith and hills

Project No. ____________

(703) 639-8783

Local ______ L.D. ✓ Placed ✓ Rec'd ______ Date 11/1/90

P. Hutchins Conversed with John Parkins

Of Hercules (Radford) Regarding Programming Doc's.

- JP returned my call and gave instructions for completing QRIP and OSD PIF forms
- He also said no forms need to be completed for ECAM projects, as they would combine many projects into a single annual submittal under the Production Support and Equipment Replacement program. He would need a project write up and life cycle cost analysis with back up calc's.

QRIP and OSD PIF FY92 implementation date

ECAM FY95 "

Escalate construction costs at __ % per year

	FY		
1.09	92	1.1358 FY 92	Call letter for PS&ER
1.1264	93	1.1737 FY 93	documents Project Administration
1.1985	95	1.2488 FY 95	

Distribution:

Telephone Call Confirmation

reynolds, smith and hills

Project No. 290 0379-000
(309) 782-5743

Local ____ L.D. ✓ Placed ____ Rec'd ✓ Date 8/31/90

P. HUTCHINS Conversed with Gary Bodtram

Of AMCCOM Regarding Energy Project Funding

G.B. indicated that the following changes in project cost requirements apply for AMC installations.

QRIP - Project Cost Range - \$5000 - \$100,000

PECIP - ≥ \$100,000

OSD PIF - ≥ \$100,000 (DOD)

ECIP does not apply for GOCOs, use ECAM instead. ECAM requires form P-15 (see AR 700-90). If greater than \$200,000, it requires form 1391. OSD PIF funds are recommended over PECIP because the money is from DOD

Distribution:

Telephone Call Confirmation

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Project No. ______

Local ______ L.D. ______ Placed ✓ Rec'd ______ Date 11/2/90

P. Hutchins Conversed with T. Pifer

Of Hercules Regarding Hercules Labor Rates

TP said to use $17.83/hr for labor rate at the Pipe Shop

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